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FEEDING ACTIVITY, RATE OF CONSUMPTION, DAILY RATION AND PREY SELECTION OF MAJOR PREDATORS IN THE JOHN DAY POOL

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ANNUAL REPORT
1982

FEEDING ACTIVITY, RATE OF CONSUMPTION, DAILY RATION AND PREY SELECTION OF MAJOR PREDATORS IN THE JOHN DAY POOL.

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ABSTRACT

This study was initiated to determine the extent of predation by resident populations of native and introduced fish on juvenile salmonids in main stem Columbia River Reservoirs. The John Day Reservoir and tailrace was selected as the study area. First year objectives were: 1) determine whether native and introduced predators preyed on juvenile salmonids; 2) determine which species were major predators; and 3) locate areas where predation was most intense. Results indicated that juvenile salmonids were consumed by all four predatory fish species studied: northern squawfish (Ptychocheilus oregonensis) walleye (Stizostedion vitreum vitreum), smallmouth bass (Micropterus dolomieu) and channel catfish (Ictalurus punctatus). However, degree of predation varied among predators as a function of spatial distribution, apparent abundance, size, and temporal feeding behavior. Northern squawfish throughout the study area consumed juvenile salmonids but large concentrations of this predator were found only in restricted zones adjacent to HcNary and John Day dams. walleye were collected primarily during spring at tailrace stations and Irrigon. Walleye had the highest mean consumption of juvenile salmonids of all predators in sprinq except at John Day forebay. Smallmouth bass were the most commonly collected predator throughout the reservoir. Mean number of juvenile salmonids consumed per smallmouth bass was lower in spring than for either northern squawfish

or walleye in spring and neared zero in summer. Channel catfish were infrequently captured and contained few juvenile salmonids. Emphasis in year two of the study will be to collect northern squawfish adjacent to dams and collect more walleye during the summer.

ACKNOWLEDGEMENTS

This study was funded by the Bonneville Power Administration. We wish to thank Richard Harper, Tom Berggren and other Bonneville Power Administration personnel for their helpful assistance. Dave Miller and the rest of the Rufus National Marine Fisheries Service crew are extended thanks for providing northern squawfish stomach samples and useful information concerning fishery operations at John Day Dam. The Oregon Department of Fish and Wildlife is thanked for providing assistance in the field.

Contract commitments could not have been met without the greatly appreciated efforts of biologists from the Willard Field Station. Sincere appreciation is extended to Gino Lucchetti for designing and constructing the new wet and dry laboratory facilities. Tom Henchman, Robert Fairley, and Martin Cobb are thanked for their cheerful assistance in the field and lab. Bill Persons is thanked for his assistance in developing numerous computer programs.

Special thanks are extended to Ginny Rehberg for entering the mounds of data on the computer, Daphne Erickson for typing the many drafts, Brenda Hilton for doing the graphics, and to Lance Beckman, Gino Lucchetti, John McIntyre, Bill Nelson, Dennis Rondorf, and Gary Wedemeyer for their thoughtful criticism of the manuscript.

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INTRODUCTION

Construction of hydropower daas and subsequent impoundment of the mainstem Columbia and Snake rivers has reduced the salmon (*Oncorhynchus* spp.) and steelhead trout (*Salmo gairdneri*) runs native to the system. While mortality associated with dam passage is considered the most serious factor affecting- the survival of juvenile salmonids (Allen 1977; Ebel 1977) other unquantified factors such as delayed migration through reservoirs in low flow years (Raymond 1979), prolonged exposure to lethal levels of dissolved gases caused by spilling (Weitkamp and Katz 1980), and predation (Ebel 1977; Raymond 1979) results in additional mortality.

It is likely that predation has long been an integral factor affecting the abundance of juvenile salmonids in the Columbia River ecosystem. However, impounding the river has changed the physical and biological characteristics of the river and created factors that increase the susceptibility of juvenile salmonids to predation. These factors may include: funneling of juvenile salmonids into a restricted area at dams; chumming effect produced by dead or disoriented juvenile salmonids passed through turbines; reduced+f lows and turbidity increasing exposure. to predators; exposure to higher water temperatures as a result of extended outmigrations; and an increase in slack water habitats preferred by native and introduced piscivorous fish. The purpose of this study is to determine the effect these factors exert on the number of juvenile salmonids consumed by predators. Study objectives are:

1. Determine the food habits, rate of consumption, daily ration and feeding activity of major predators.
2. Determine the pattern of prey selection of major predators as a function of time and reservoir habitat.
3. Estimate the rate of gastric evacuation of major predators.

First year objectives were:

1. Determine whether resident native and exotic fish prey on juvenile anadromous salmonids.
2. Determine which species are responsible for the majority of the predation problem.
3. Locate areas of the reservoir where predation is most intense.
4. Determine whether predators and prey can be held in an artificial environment for laboratory studies.

STUDY- AREA AND SAMPLING STATIONS

John Day Reservoir (Fig. 1) was selected as the study site because previous studies on the reservoir indicated that subyearling chinook salmon (O. *tschawytscha*) rear in the reservoir, passage and residualism of juvenile salmonids are considered problems there, and a substantial population of predators reside in the reservoir and tailrace (Hjort et al. 1981). In addition, collection facilities at

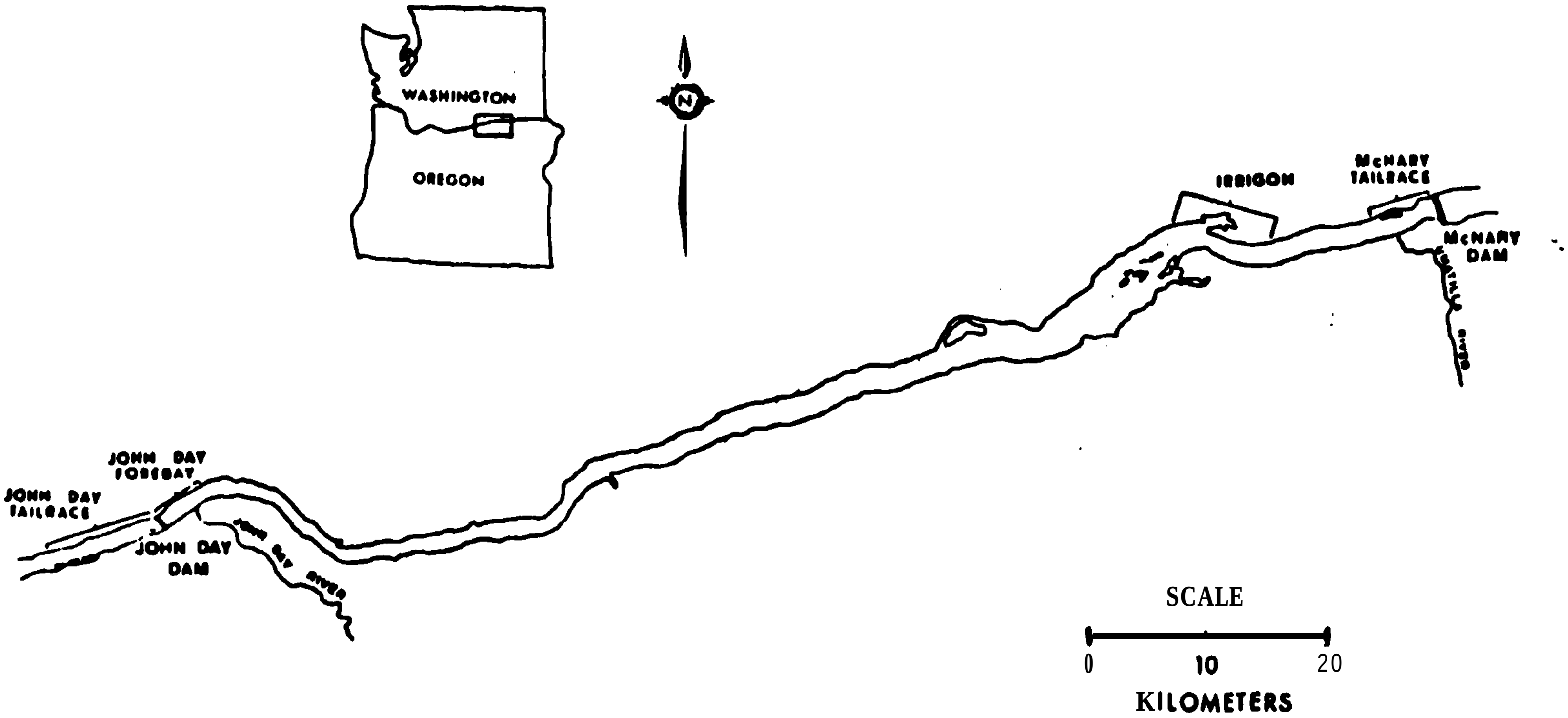

Figure 1. Location of four stations sampled in John Day Reservoir and tailrace, April to December 1982.

McNary and John Day dams monitor the abundance of juvenile salmonids in John Day Reservoir.

The impoundment was formed by the closure of John Day Dam in 1968. The reservoir has an average width of 1.8 km, surface area of about 20,000 hectares, and a normal pool elevation of 80.5m above mean sea level (Bell et al. 1976). The dam was designed for flood control, hydropower, and navigation.

Four sampling stations were selected in three reservoir areas (Fig. 1). The McNary tailrace station (river km 464-470) represented a reservoir area influenced by turbine outflow and spill (Pig. 2). The mid-reservoir station (river km 444-454) at Irrigon, Oregon typified reservoir habitats away from the direct influence of dams (Fig. 3). The John Day forebay station (river km 347-349) represented an area where juvenile salmonids concentrate prior to dam passage (Fig. 4). The John Day tailrace station (river km 338-347) was chosen as a secondary station to compare with McNary tailrace (Fig. 5).

METHODS

Four predatory species, northern squawfish (Ptychocheilus oregonensis), walleye (Stizostedion vitreum vitreum), smallmouth bass (Micropterus dolomieui), and channel catfish (Ictalurus punctatus) were selected for study. Selection was based on a literature review which indicated they attain high relative abundance, large size at

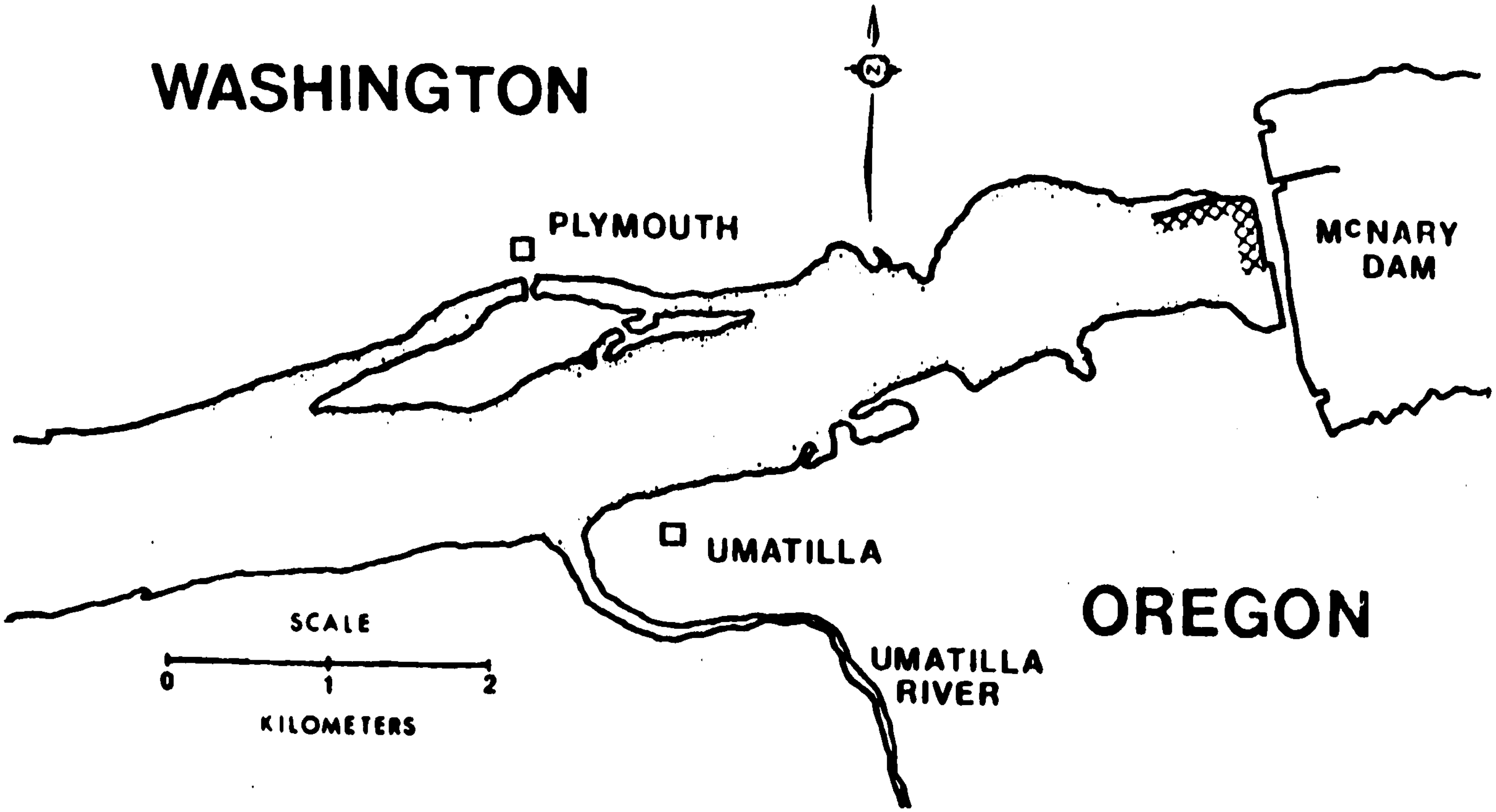

Figure 2. Location of shoreline areas sampled at McNary tailrace during 1982. Sampling areas within the restricted zone are shown with grid pattern and others with speckled pattern.

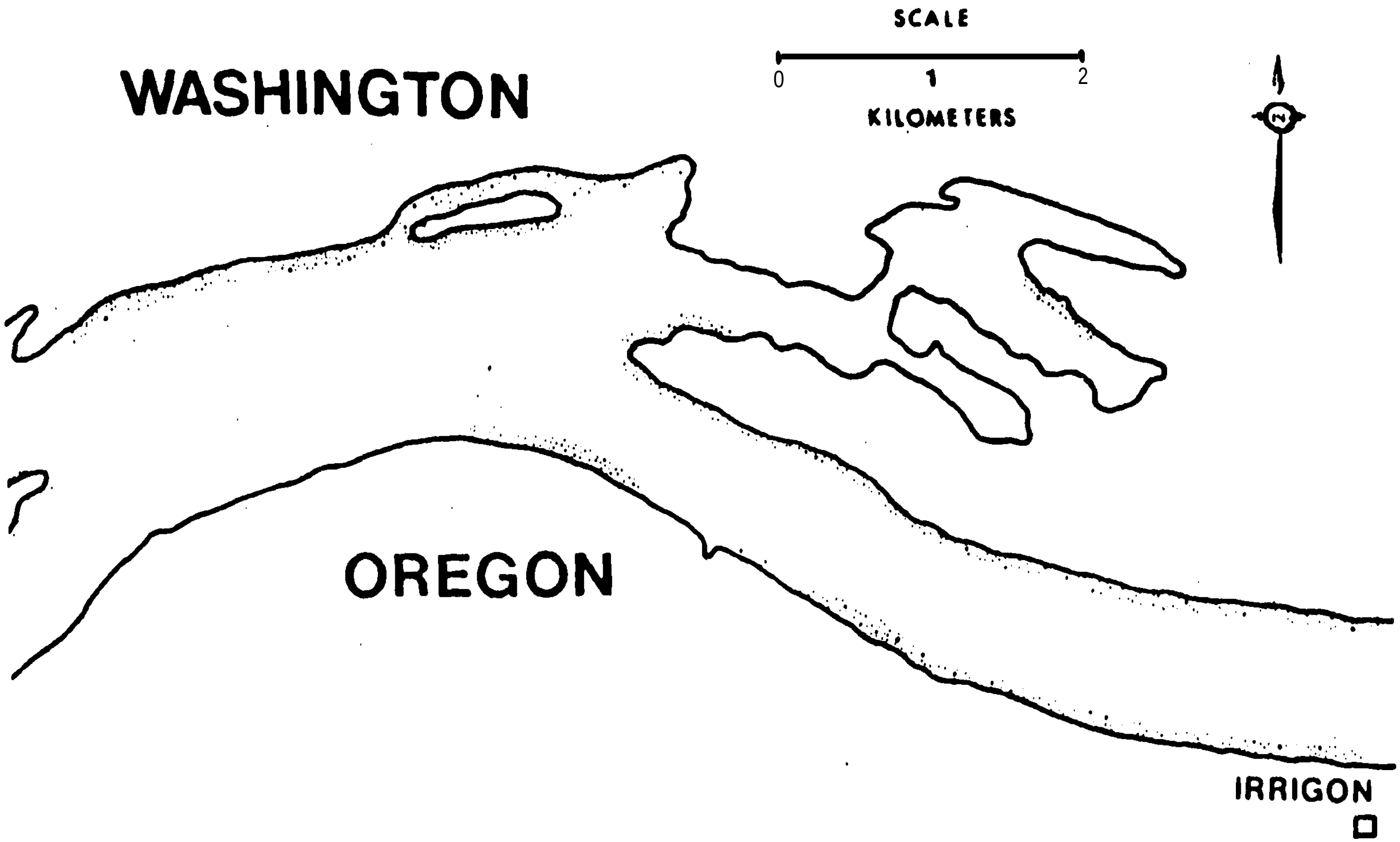

Figure 3. Location of shoreline areas sampled at Irrigon during 1982. Sampling areas are shown with speckled pattern.

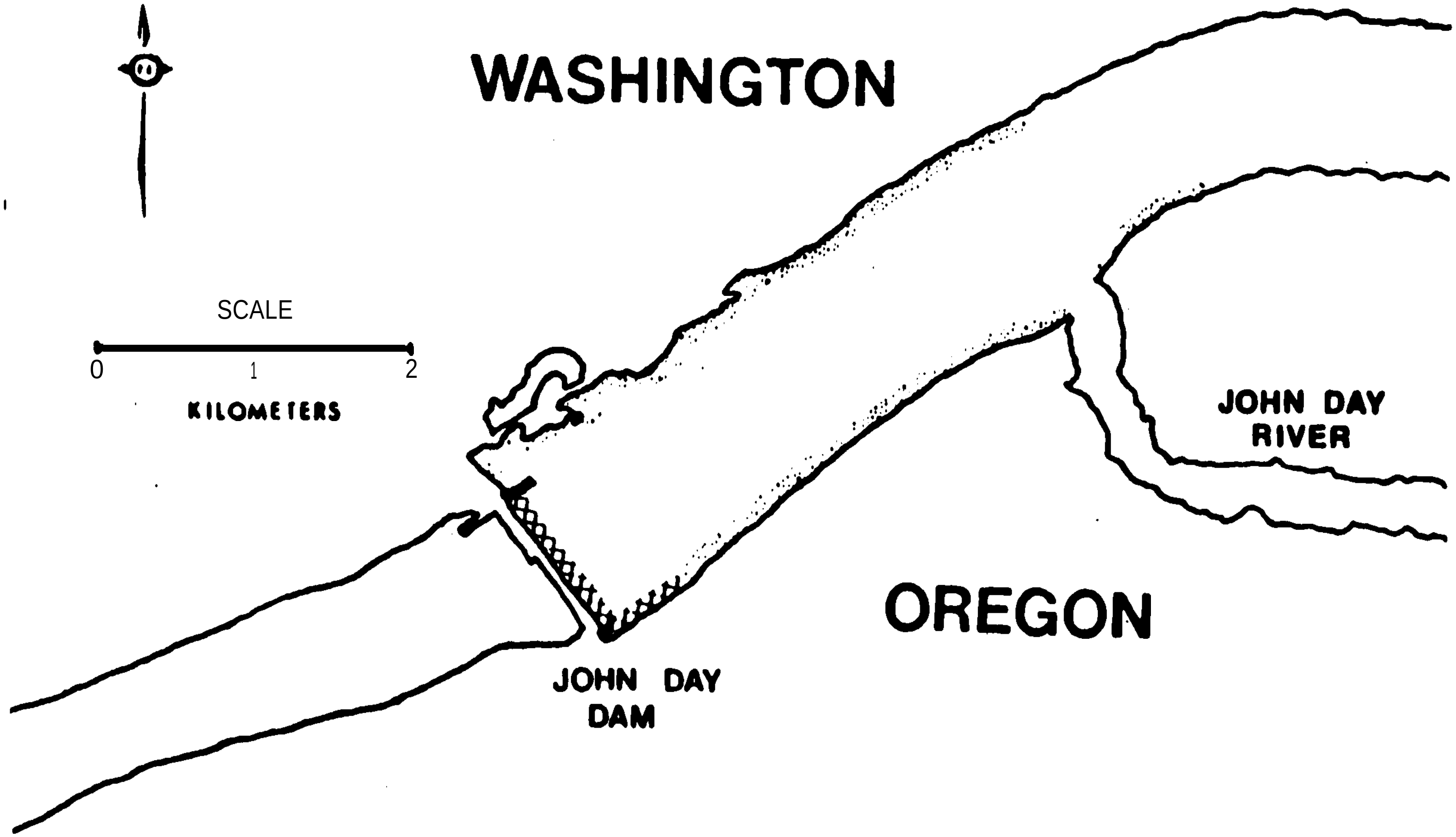

Figure 4. Location of shoreline areas sampled at John Day forebay during 1982. Sampling areas within the restricted zone are shown with grid pattern and others with speckled pattern.

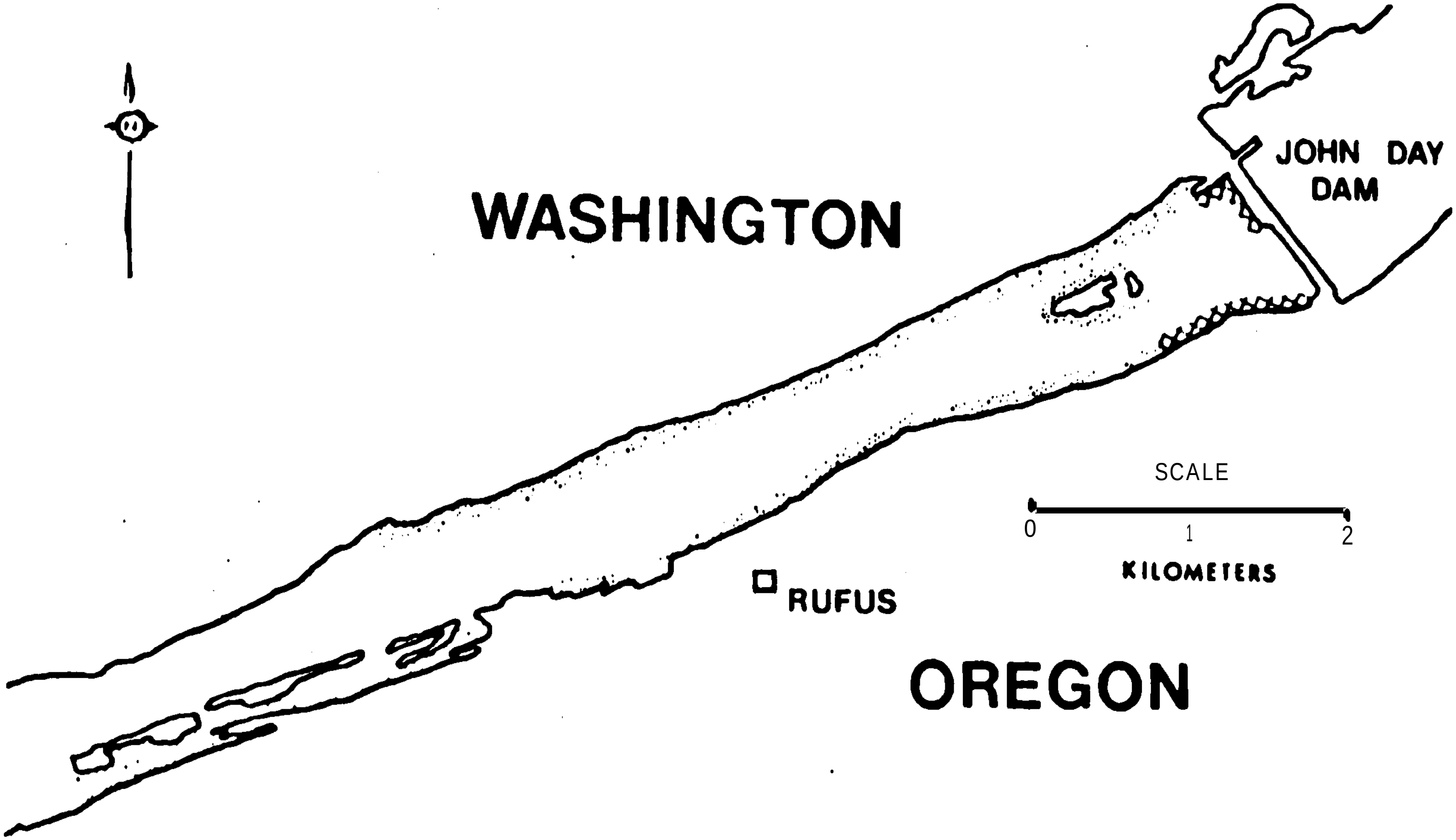

Figure 5. Location of shoreline areas sampled at John Day tailrace during 1982. Sampling areas within the restricted zone are shown with grid pattern and others with speckled pattern.

maturity, and wide distribution required for a species to be a significant predator (Bennett et al. 1983; Hjort et al. 1981).

Several sampling gears were used to collect predators but emphasis was placed on electrofishing and trawling to limit regurgitation and digestion of food following capture. Stomach contents of predators were analyzed to determine the relative importance of juvenile salmonids in the diet. Areas of the reservoir where predation was most intense were identified by comparing stomach contents and apparent abundance of predators at each station. Initial laboratory studies to determine whether predators and prey can be held in an artificial environment were postponed because of delays in completing wet laboratory facilities.

Sampling Design

Standardized Sampling

Die1 sampling was conducted monthly from April to November with a boat electroshocker, at the McNary tailrace, Irrigon, and John Day forebay and quarterly at John Day tailrace. Fish were collected by electroshocking designated transects (Fig. 2-5) for 15 minutes (power on) every 1.5 hours throughout a 24 hour period at each station. Voltage settings ranging from 540 to 840 D.C. were used to maintain a steady current of 5 amps in the 60 pulse per second output mode.

Depths fished were generally less than 3 m but reached 7-11 m in areas adjacent to McNary and John Day dams.

Captured predators were anesthetized with Benzocain, counted, measured to total length (1.0 mm), and weighed (1.0 gm). Scales or pectoral spines were removed for age determination using standard techniques. Stomachs of smallmouth bass greater than 100 mm in length and walleye greater than 200 mm in length were pumped using a modification of the technique developed by Seaburg (1957). Food material was then strained (333 µ sieve) and preserved in 10% formalin. A subsample of the pumped smallmouth bass and walleye stomachs were sacrificed to estimate the efficiency of the pumping technique. Remaining pumped fish were tagged and released. Smallmouth bass less than 100 mm in lenqth and walleye less than 200 mm in length were preserved whole in 10% formalin. Digestive tracts of channel catfish and northern squawfish were removed and preserved in 10% formalin because pumping proved inefficient.

Supplemental Sampling

Supplemental sampling was conducted to increase the number of stomachs available for analysis and locate concentrations of predators in areas not regularly sampled. Gear selected for supplemental sampling was based on the target species. Electroshockinq was effective for collecting walleye, northern squawfish, and smallmouth bass at night and was conducted at all sampling stations on an irregular basis.

Bottom trawls towed by a 7 m boat fitted with hydraulic winches and towing stanchion were used to collect walleye during daylight hours. Bottom trawling occurred at Irrigon, McNary tailrace, and John Day tailrace. Three types of bottom trawls were used for sampling: a 9 m semi-balloon trawl with 10 cm stretched mesh in the body and 7.5 cm stretched mesh in the codend; a 7.5 m four seam otter trawl with 10 cm stretched mesh in the body and 7.5 cm stretched mesh in the codend; and a 10.5 m four seam otter trawl with 7.5 cm stretched mesh in the dogears, bosom, and square, 5 cm stretched mesh in the body, and 4.4 cm stretched mesh in the intermediate and codend. Bottom trawling transects were located in relatively snag-free areas with gentle bottom contours; water depth ranged from 1.2 a to 10.8 m. Duration of tows ranged from 3 to 20 minutes with a mean of 8.7 minutes.

Midwater trawling for northern squawfish was conducted at John Day forebay during daylight hours. The midwater trawl had a 12 m square opening with 12.7 cm stretched mesh in the dogears, bosom, and square, 7.5 cm stretched mesh in the body, 5 cm stretched mesh in the funnel, and 3.8 cm stretched mesh in the intermediate, fyke, and codend. The fyke and codend were eventually removed to reduce drag and increase towing speed. Duration of tows ranged from 15 to 25 minutes with a mean of 20 minutes.

The National Marine Fisheries Service collected northern squawfish for us using a 244 m x 10.7 m purse seine with knotless mesh measuring 6.35 mm. Whole or partial digestive tracts of these fish were removed, injected with lO% formalin, and placed in 70% alcohol.

Bottom gill nets were used to collect channel catfish. Nets were multifilament mesh, measuring 60 m by 1.8 a and consisted of eight 7.6 m panels with stretch mesh sizes graduated from 2.5 cm to 20.3 cm in 2.5 cm increments. Samplinq with gill nets was restricted to McNary tailrace, Irrigon and John Day forebay. Nets were set at 30 minute intervals beginning two hours prior to sunrise and sunset and lifted four hours later. Nets were set in water depths ranging from 1 m to 23 m.

Laboratory Analysis

Apparent Abundance

Apparent abundance of northern squawfish (>250 mm), walleye (>200 mm), and smallmouth bass (>150 mm) was derived from catch per effort data collected during standardized sampling with the boat electroshocker. The standard unit of effort was one 15 minute transect. Data were summarized by species, station, and season. The apparent abundance of channel catfish was estimated from gill net catches. The standard unit of effort was a four hour set. Data were summarized by station and month.

Stomach Pump Efficiency

Efficiency of collecting stomach contents with a pumping device was estimated by inspecting a subsample of pumped stomachs. Overall efficiency was calculated by:

$$E = \frac{P}{P+T} \times 100$$

where E was the percent efficiency, P was the weight of all pumped food items, and T was the weight of all food items retrieved during stomach inspections. Mean efficiency was calculated by:

$$ME = \frac{\sum \frac{IP}{IP + IT}}{N} \times 100$$

where ME was the mean percent efficiency, IP was the weight of pumped food items for each fish sampled, IT was the weight of food items retrieved from each fish during the stomach inspection, and N was the total number of stomachs sampled. Only fish with identified food items were included in the analysis.

Stomach Analysis

A concern during the first year of study was to determine the food habits of predators large enough to consume juvenile salmonids. Since no definitive information was available on the length at which these fish become predacious on juvenile salmonids in Columbia basin reservoirs we arbitrarily divided each species into the following length groups:

	Northern Squawfish	Walleye	Smallmouth Bass	Channel Catfish
Small	<250 mm	<200 mm	<150 mm	<150 mm
Large	>250 mm	> 200 mm	>150 mm	>150 mm

Techniques used to analyze fish in each group were similar. However, results presented are limited to the larger size group for each species. Results from the analysis of fish in the small length groups will be presented in a future report.

Techniques used to analyze the stomach contents were standardized when possible but-some variation occurred because of differences between pumping (walleye and smallmouth bass1 and removing stomachs (northern squawfish and channel catfish). Stomach contents of walleye, smallmouth bass, and channel catfish were enumerated as a single unit while those from northern squawfish were divided into foregut (esophagus to anterior most bend in digestive tract) and hindgut (end of foregut to anus). Stomach contents of northern squawfish were separated to allow future comparisons with a previous study at Bonneville Dam in which only foregut material was analyzed (Uremovich et al. 1980).

Contents of stomachs were identified and enumerated to the lowest practical taxonomic level, given the degree of digestion, with a variable powered dissecting microscope. Typically, crustaceans were identified to species or family, insects to family or order, and fishes to species or family. Parasites, non-food items, and unidentified material were noted during examination but excluded from dietary calculations.

Stomach material from each taxomonic group was enumerated by counting whole organisms or unique morphological parts. When food items from a single taxonomic group were too numerous to count, an estimate was made by dividing the total weight of the taxonomic qroup by the average weight of a single member of that group. When a portion of an organism was found in foregut and hindgut of a northern squawfish digestive tract, the item was assigned to the foregut unless parts from the hindgut were required for taxonomic identification. Eggs, filanentous algae, miscellaneous debris were grouped and given a numerical count of "1".

Taxonomic groups were weighed (wet weiqht) to the nearest milligram on a digital balance after being blotted on a paper towel for one minute to achieve a standard degree of wetness. Food material which could not be blotted was dried to a standard degree of wetness with a Buchner funnel and weighed in the following manner:

1. A dry filter paper was placed on a Buchner funnel and soaked with water.

2. Excess water was drawn from the filter paper by operating the Buchner funnel for two minutes.

3. The moist filter paper was weighed to the nearest milligram.

4. The filter paper was returned to the funnel and food material to be dried was rinsed onto the filter paper with water.

5. For two minutes, excess moisture was drawn away from food material and filter paper by the Buchner funnel.

6. Food and filter paper were weighed together to the nearest milligram.

7. Weight of the moist filter paper alone (2) was subtracted from the weight of moist filter paper and food material combined (6) to obtain wet weight of food.

Items in each taxonomic group from foregut and hindgut of northern squawfish were weighed together. Weight of remains from several partially digested fish was apportioned based on relative weight and degree of digestion of each fish. When only digested parts remained and relative size of each fish could not be determined, weight of the parts were divided equally among fish. Taxonomic groups weighing less than 1 mq were recorded as "0.001 g".

Data were entered into a Wanq 2200 computer for analysis. Indices used in the analysis included: mean number, percent composition by number, percent composition by weiqht, and percent occurrence. These indices were used to analyze relationships between food habits and capture location, time of capture, size, and season for each predatory species. Months for spring (April to June), summer (July to September), and fall (October to December) seasons were arbitrarily selected. In some cases, stations adjacent to dams (McNary, John Day forebay and John Day tailrace) were subdivided into areas inside and out of restricted zones (Fig. 2-5) to enhance analysis.

Age Determination

Scale samples of walleye and smallmouth bass were cleaned and then pressed on acetate slides using a heated press. Scale impressions were viewed using a microfiche projector at magnifications of 42 or 72. Criteria for recognition of annuli were abrupt changes in spacing of circuli on the anterior field and anastomosis or "crossing over" of circuli on the lateral field. Aqe determinations were based on at least two scale readings.

RESULTS

Apparent Abundance

Mean catch per transect (CPT) of northern squawfish, walleye, and smallmouth bass during 1982 indicated wide variability in apparent abundance among sampling stations (Table 1). Northern squawfish were most abundant at John Day forebay but were also abundant at McNary tailrace and John Day tailrace. Overall mean CPT of northern squawfish at these stations ranged from 1.67 to 2.51 fish per transect, however, catch rates in restricted zones were substantially higher than catch rates out of restricted zones. Catch rates of walleye were highest at John Day tailrace and lowest at John Day forebay. Catch rate of smallmouth bass at John Day forebay was at least twice that of other stations sampled.

Mean CPT also identified dominant predators at each sampling station (Table 1). Northern squawfish were the dominant predator collected within the restricted zone at McNary tailrace, John Day forebay and John Day tailrace. Predator dominance outside the restricted zone at McNary tailrace was shared among northern squawfish, walleye, and smallmouth bass. Smallmouth bass were the dominant predator outside the restricted zone at John Day forebay and northern squawfish dominanted outside the restricted zone at John Day tailrace. Smallmouth bass were the most abundant predator at Irriqon.

Seasonal fluctuations in apparent abundance of predators were observed (Table 1). Seasonal fluctuations in CPT of walleye and smallmouth bass were similar among samplinq stations. Catch rates for these species were highest in spring and steadily declined throuqh summer and fall. Seasonal abundance of northern squawfish differed among sampling stations. At Irriqon, catch rates of northern

Table 1. Mean catch per transect (CPT) of northern squawfish, walleye, and smallmouth bass collected with boat electroshocker by season at each station in John Day Reservoir and tailrace, 1382.

Species and station	Spring T[3]	Spring CPT	Summer T	Summer CPT	Fall T	Fall CPT	Mean CPT
Northern squawfish							
McNary tailrace (overall)	52	0.33	17	4.35	32	1.78	2.15
RZ[1]	0	-	4	17.75	8	6.25	12.00
ORZ[2]	52	0.33	13	0.23	24	0.29	0.28
Irrigon	48	0.58	49	0.31	31	0.03	0.31
John Day forebay (overall)	46	1.13	16	4.50	32	1.91	2.51
RZ	0	-	4	11.75	8	6.00	8.88
ORZ	46	1.13	12	2.08	24	0.54	1.25
John Day tailrace (overall)	16	0.44	16	2.69	17	1.88	1.67
RZ	0	-	0		7	4.43	4.43
ORZ	16	0.44	16	2.69	10	0.01	1.08
Walleye							
McNary tailrace	52	0.37	50	0.18	32	0.13	0.23
Irrigon	48	0.42	49	0.04	31	0.00	0.15
John Day forebay	46	0.04	49	0.00	32	0.00	0.01
John Day tailrace	16	1.63	16	0.50	17	0.06	0.73
Smallmouth bass							
McNary tailrace	52	0.40	50	0.38	32	0.00	0.26
Irrigon	48	2.33	49	0.88	31	0.00	1.07
John Day forebay	46	4.15	49	1.88	32	0.72	2.25
John Day tailrace	16	1.00	16	0.63	17	0.00	0.54

1 Restricted zone; Sampled from September to November.
2 Out of restricted zone; Sampled from April to November.
3 Number of transects.

squawfish followed a seasonal pattern similar to those observed for walleye and smallmouth bass. Conversely, catch rates of northern squawfish were higher in summer and fall than in spring at forebay and tailrace stations.

Mean catch per lift (CPL) of channel catfish varied by station over time (Table 2). Overall mean CPL of channel catfish was highest at John Day forebay and lowest at Irrigon. Monthly catch rates at each station were highly variable and exhibited no trend.

Food habits of Northern Squawfish

Digestive tract contents of 748 northern squawfish collected from April to December were analyzed. Lengths of fish examined ranged from 254 to 577 mm. About 35% of the guts examined (259) contained no identifiable food. Digestive tracts collected by the National Marine Fisheries Service were eliminated from the analysis because they may have biased estimates of juvenile salmonid consumption. This decision was based on the high number of northern squawfish digestive tracts containing largely undiqested juvenile salmonids, a condition rarely observed in digestive tracts collected by boat electroshocker or bottom trawl. It was quite likely that these northern squawfish were feedinq on juvenile salmonids in the purse seine.

Table 2. Mean catch per lift (CPL) of channel catfish collected with bottom gill nets by month at each station in John Day Reservoir, 1982.

Month	John Day forebay[1] Lifts	John Day forebay[1] CPL	Irrigon Lifts	Irrigon CPL	McNary tailrace Lifts	McNary tailrace CPL
June	6	0.67	6	0.17	6	1.67
July	12	1.75	6	0.50	6	0.17
August	6	1.17	6	0.67	6	1.17
September	6	1.00	12	0.25	3	0.33
October	6	0.50	4	0.00	4	0.00
Overall mean		1.02		0.32		0.67

[1] Majority of effort in lower 2 km of John Day River.

The diet of northern squawfish included a wide variety of food items (Table 3 and Appendix 1). Fish, insects and crustaceans were important in the diet, occurring in 31.08, 31.2%, and 21 .l% of the guts, respectively. Fish were the dominant prey of northern squawfish by weight (74.991, whereas insects were numerically dominant (90.3%).

The fish portion of the northern squawfish diet was composed principally of juvenile salmonids and American shad (Alosa sapidissima). American shad were of greater dietary importance than salmonids in terms of percent occurrence (12.2% to 9.8%) and percent number (0.7% to 0.4%) but salaonids comprised a slightly greater proportion of the diet by weight (30.9% to 28.4%). Salmonids and American shad combined accounted for 59.3% of the total weiqht of food items. Sculpins (Cottus spp.) chiselmouth (Acrocheilus alutaceus) northern squawfish, peamouth (Mylocheilus caurinus), and suckers (Catostomus spp.) occurred less frequently but were important by weight.

Invertebrates accounted for 98.4% of the food items in northern squawfish by number and 23.7% by weight. Hymenoptera was the most abundant invertebrate food qroup, contributing 84% by number and 11.7% by weight.

Variation in physical characteristics of areas sampled affected the results of seasonal food habit analysis for northern squawfish. From April to late August high water flows and other factors prevented sampling in restricted zones at McNary tailrace, John Day forebay,

Table 3. Mean number, percent occurrence, percent number, and percent weight of food items in digestive tracts of 748 northern squawfish (>250mm) collected in John Day Reservoir and tailrace, April to December 1982.

Food item	Mean number	Percent occurrence	Percent number	Percent weight
MUSSELS				
Corbicula manilensis	0.09	1.6	0.3	1.9
CRUSTACEANS	2.69	21.1	7.9	8.9
Cladocera	<0.01	0.3	<0.1	CO.1
Amphipoda	2.54	11.1	7.4	0.6
Anisogammarus spp.	0.14	2.7	0.4	<0.1
Corophium spp.	2.40	10.4	7.0	0.6
Decapoda				
Pacifastacus leniusculus	0.16	12.4	0.5	8.3
INSECTS	30.75	31.1	90.3	12.9
Ephemeroptera	0.17	7.1	0.5	0.3
Odonata	to.01	0.1	co.1	to.1
Orthoptera	<0.01	0.4	<0.1	<0.1
Hemiptera	0.10	3.2	0.3	<0.1
Homoptera	0.09	2.5	0.3	<0.1
Coleoptera	0.47	7.0	1.4	0.3
Trichoptera	0.12	3.9	0.4	<0.1
Diptera	0.84	9.8	2.5	0.2
Hymenoptera	28.62	13.9	84.0	11.7
Unidentified insects	0.33	11.1	1.0	0.5
FISH	0.48	31.0	1.4	74.9
Clupeidae				
Alosa sapidissima	0.23	12.2	0.7	28.4
Salmonidae	0.12	9.8	0.4	30.9
Oncorhynchus tshawytscha	0.02	1.6	0.1	11.0
Prosopium williamsoni	to.01	0.1	to.1	to.1
Salmo gairdneri	<0.01	0.3	to.1	2.5
Unidentified salmonidae	0.09	7.8	0.3	17.4
Cyprinidae	0.02	1.6	0.1	4.1
Acrocheilus alutaceus	0.01	0.7	<0.1	3.1
Mylocheilus caurinus	<0.01	0.4	<0.1	0.2
Ptychocheilus oregonensis	0.01	0.8	to.1	0.7
Catostomidae				
catostorus spp.	0.01	1.3	<0.1	4.7
Ictaluridae				
Ictalurus spp.	<0.01	0.1	to.1	to.1
Percopsidae				
Percopsis transmontana	<0.01	0.3	<0.1	to.1
Centrarchidae	0.31	0.8	to.1	0.9
Cottidae				
Cottus spp.	0.04	3.5	0.1	5.0
Unidentified non-salmonidae	0.01	1.5	to.1	0.5
Unidentified Osteichthyes	0.03	2.5	0.1	3.4
OTHER FOOD	0.02	1.1	to.1	1.4

and John Day tailrace. Therefore, data from digestive tracts collected in and out of the restricted zone at each station were analyzed separately.

Crustaceans (primarily Pacifastacus leniusculus) were the predominant food consumed by northern squawfish outside the restricted zone at the McNary tailrace in spring (Table 4), with a mean number of 8.32 per digestive tract and accounting for 91.3% by number and 74.4% by weight. Fish were of secondary importance, contributing 23.6% by weight and a mean of 0.16 per stomach. No salmonids were found in northern squawfish collected outside the restricted zone at McNary tailrace in spring.

Fish were the most important food item by weight in northern squawfish digestive tracts from Irriqon (55.3%) and outside restricted zones at John Day forebay (80.6%) and tailrace (69.2%) in spring. Salmonids were the single most important fish group by weight at Irrigon (35.4%) and John Day forebay (61.8%), while at John Day tailrace they were third in importance (2.0%) behind chiselmouth (44.2%) and suckers (23.0%). Mean number of salmonids per northern squawfish was also considerably higher at Irriqon (0.23) and John Day forebay (0.16) than at John Day tailrace (0.03) in spring.

In spring, crustaceans were the most abundant food group in the diet of northern squawfish at Irrigon and outside the restricted zone at John Day forebay and John Day tailrace, contributing 0.71 and 38.69, 5.72 and 76.3% and 1.92 and 78.9% by mean number and percent

Table 4. Mean number, percent occurrence, percent number, and percent weight of food items in digestive tracts of northern squawfish by station in John Day Reservoir and tailrace, spring 1982. Sample sizes are in parentheses.

		Outside restricted zone			
		Mean	Percent		
Station	Food item	number	occurence	number	weight
McNary tailrace (19)	Mussels	0.00	0.0	0.0	0.0
	Crustaceans	8.32	36.8	91.3	74.4
	Insects	0.63	26.3	6.9	1.9
	Fish	0.16	10.5	1.7	23.6
	Salmonidae	0.00	0.0	0.0	0.0
	Other food	0.00	0.0	0.0	0.0
Irrigon (31)	Mussels	0.10	5.4	5.3	1.8
	Crustaceans	0.71	40.5	38.6	27.5
	Insects	0.52	24.3	28.1	0.4
	Fish	0.45	32.4	24.6	55.3
	Salnonidae	0.23	18.9	12.3	35.4
	Other food	0.06	2.7	3.5	15.0
John Day forebay (67)	Mussels	0.00	0.0	0.0	0.0
	Crustaceans	5.72	34.3	76.3	18.4
	Insects	1.46	23.9	19.5	1.1
	Fish	0.31	29.9	4.2	80.6
	Salmonidae	0.16	16.4	2.2	61.8
	Other food	0.00	0.0	0.0	0.0
John Day tailrace (37)	Mussels	0.05	5.4	2.2	0.8
	Crustaceans	1.92	24.3	78.9	26.5
	Insects	0.30	10.8	12.2	1.6
	Fish	0.14	10.8	5.6	69.2
	Salmonidae	0.03	2.7	1.1	2.0
	Other food	0.03	2.7	1.1	1.9

number, respectively. Crustaceans were also the second most important food item by weight at these three locations (Table 5).

Fish provided the most weight of all food groups consumed by northern squawfish outside the restricted zones during the summer, accounting for 63.1% by weight at McNary tailrace, 68.6% at Irrigon, 46.9% at John Day forebay and 55.6% at John Day tailrace. Salmonids were never the most important fish by weight outside restricted zones during the summer but their importance did increase from spring to summer at John Day and McNary tailraces (10.0% and 9.29, respectively). Percent weight of salmonids declined between spring and summer at John Day forebay (61.8% to 13.8%) and Irriqon (35.4% to 0%).

There was a general decline in the numerical importance of crustaceans in northern squawfish digestive tracts collected outside restricted zones from spring to summer. Northern squawfish increased their utilization of insects at all stations except at Irriqon during the same period (Table 5).

Food consumed by northern squawfish in restricted zones differed substantially from that consumed at other areas during the summer (Table 5). In tailrace restricted zones northern squawfish consistently fed more heavily on fish, while at John Day forebay insects (primarily Formicidae) were the predominant food item consumed (Table 5). Salmonids were the most important fish by weight in the diet of northern squawfish in restricted zones at McNary tailrace (83.3%) and John Day forebay (5.5%) while subyearlinq American shad

Table 5. Mean number, percent occurrence, percent number, and percent **weight** of food items in digestive tracts of northern squawfish by station in John Day Reservoir and tailrace, summer 1982. Sample sizes are in parentheses.

Station	Food item	Outside restricted zone				Within restricted zone			
		Mean	Percent			Mean	Percent		
		number	occurrence	number	weight	number	occurrence	number	weight
McNary									
tailrace	Mussels	0.92	11.5	5.8	13.8	0.04	5.2	1.1	0.4
(outside 26)	Crustaceans	12.73	53.8	79.8	20.6	1.31	15.0	39.5	0.8
(inside 113)	Insects	2.08	34.6	13.0	2.4	1.58	23.0	47.5	0.4
	Fish	0.23	23.1	1.5	63.1	0.40	34.5	12.0	98.4
	Salmonidae	0.08	7.7	0.5	9.2	0.27	22.1	8.3	83.3
	Other food	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
riqon									
	Mussels	0.33	8.3	3.5	12.1				
(outside 12)	Crustaceans	0.17	8.3	1.8	co.1				
	Insects	8.08	50.0	86.6	19.2		Not applicable		
	Fish	0.75	41.7	8.0	68.6				
	Salmonidae	0.00	0.0	0.0	0.0				
	Other food	0.00	0.0	0.0	0.0				
John Day									
forebay	Mussels	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
(outside 112)	Crustaceans	1.20	23.5	1.7	9.9	0.74	9.1	0.4	0.1
(inside 22)	Insects	70.12	40.2	97.9	43.2	192.35	87.0	99.5	91.2
	Fish	10.27	15.7	0.4	46.9	0.09	9.1	0.0	8.6
	Salmonidae	0.13	6.9	0.2	13.8	0.01	1.3	0.0	5.5
	Other food	0.01	1.0	0.0	0.0	0.05	5.2	0.0	0.0
John Day									
tailrace	Mussels	0.51	9.8	3.9	16.0	0.00	0.0	0.0	0.0
(outside 61)	Crustaceans	10.61	39.3	82.0	26.5	0.00	0.0	0.0	0.0
(inside 35)	Insects	1.44	18.0	11.2	1.9	0.00	0.0	0.0	0.0
	Fish	10.34	19.7	2.7	55.6	1.57	91.4	100.0	100.0
	Salmonidae	0.05	4.9	0.4	10.0	0.11	11.4	7.3	17.4
	Other food	0.03	3.3	0.3	0.1	0.00	0.0	0.0	0.0

contributed the most weight in the restricted zone at John Day tailrace (81.6%). Mean number of salmonids consumed per northern squawfish was higher in restricted zones at McNary and John Day tailraces than outside restricted zones (Table 5); at John Day forebay the opposite was true (Table 5).

In the fall, fish were the most important dietary component by weight in northern squawfish digestive tracts collected outside the restricted zone at John Day forebay (63.5%) and crustaceans (80.1%) dominated at McNary tailrace (Table 6). Sculpins accounted for the majority of identified fish material in northern squawfish collected outside the restricted zone at John Day forebay in the fall (58.3%).

A distinct difference remained in the importance of fish and other food items in the diet of northern squawfish outside and inside restricted zones in the fall (Table 6). Northern squawfish continued to feed more heavily on fish in the restricted zone at McNary and increased their utiliztion of fish in John Day forebay. Utilization of insects by northern squawfish decline3 in and out of the restricted zone at John Day forebay but the decline was slightly more pronounced outside the restricted zone.

American shad replaced juvenile salmonids as the dominant food item in northern squawfish digestive tracts by weight in restricted zones at McNary tailrace and John Day forebay in the fall (Table 6). American shad also remained the most important food item by weight in the restricted zone at John Day tailrace. Salmonids were of

Table 6. Mean number, percent occurrence, percent number, and percent weight of food items in digestive tracts of northern squawfish by station in John Day Reservoir and tailrace, fall 1982. Sample sizes are in parentheses.

		Outside restricted zone				Within restricted zone			
		Mean	Percent			Mean	Percent		
Station	Food item	number	occurrence	number	weight	number	occurrence	number	weight
McNary									
tailrace	Mussels	0.17	16.7	2.9	2.3	0.00	0.0	0.0	0.0
(outside 6)	Crustaceans	0.83	66.7	14.3	80.1	0.09	5.5	3.3	0.9
(inside 55)	Insects	3.67	16.7	62.9	0.8	2.05	25.5	73.4	1.4
	Fish	0.50	50.0	8.6	16.9	0.56	45.5	20.1	89.2
	Salmonidae	0.17	16.7	2.9	2.1	0.09	9.1	3.3	32.6
	Other food	0.67	16.7	11.4	<0.1	0.09	7.3	3.3	8.6
Irrigon									
	Mussels	0.00	0.0	0.0	0.0				
(outside 1)	Crustaceans	0.00	0.0	0.0	0.0				
	Insects	2.00	100.0	100.0	100.0		Not applicable		
	Fish	0.00	0.0	0.0	0.0				
	Salmonidae	0.00	0.0	0.0	0.0				
	Other food	0.00	0.0	0.0	0.0				
John Day									
forebay	Mussels	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
(outside 15)	Crustaceans	1.80	26.7	71.0	36.5	0.41	6.1	7.0	0.7
(inside 49)	Insects	0.20	6.7	7.9	<0.1	4.67	34.7	80.6	18.2
	Fish	0.53	33.3	21.1	63.5	0.35	26.5	6.0	81.0
	Salmonidae	0.00	0.0	0.0	0.0	0.04	4.1	0.7	37.3
	Other food	0.00	0.0	0.0	0.0	0.37	8.2	6.3	0.1
John Day									
tailrace	Mussels	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
(outside 2)	Crustaceans	0.00	0.0	0.0	0.0	0.05	2.7	1.4	2.3
(inside 37)	Insects	0.50	50.0	16.7	0.1	1.68	2.7	43.4	0.1
	Fish	2.50	50.0	83.3	94.9	2.11	78.4	54.6	96.4
	Salmonidae	0.00	0.0	0.0	0.0	0.11	8.1	2.8	17.1
	Other food	0.00	0.0	0.0	0.0	0.03	2.7	0.7	1.2

greater importance by weight in digestive tracts of northern squawfish inside restricted zones than outside durinq the fall at McNary tailrace (32.6% to 2.1%), John Day forebay (37.3% to 0%), and John Day tailrace (17.1% to 0%). Mean number of salmon and steelhead trout were also consistently higher in northern squawfish collected in restricted zones than outside these zones in the fall (Fig. 6).

Die1 food habits of northern squawfish were analyzed by comparing percent weight of major food groups in all digestive tracts- examined over six hour intervals (Fig. 7). Fish were the primary food in northern squawfish digestive tracts during each six hour interval and were most important between 0600 and 1200 hours (85.5%). As a group, salmonids were also most important between 0600 and 1200 hours (49.3%). Insects contributed most to the diet between 1800 and 2400 hours (19.5%), when the weight of fish material was lowest (62.0%). Crustaceans were most important between 1200 to 1800 hours, accounting for 17.2% of the total weight.

Northern squawfish from 250 to 300 mm in length fed primarily on invertebrates while larqer northern squawfish fed primarily on fish (Fig. 8). The importance of fish in the diet steadily increased with size for northern squawfish over 300 mm in length. Salmonids were found in northern squawfish as small as 324 mm in lenqth. Salmonids were most important in the diet of northern squawfish 450 to 500 mm in length (44.0%).

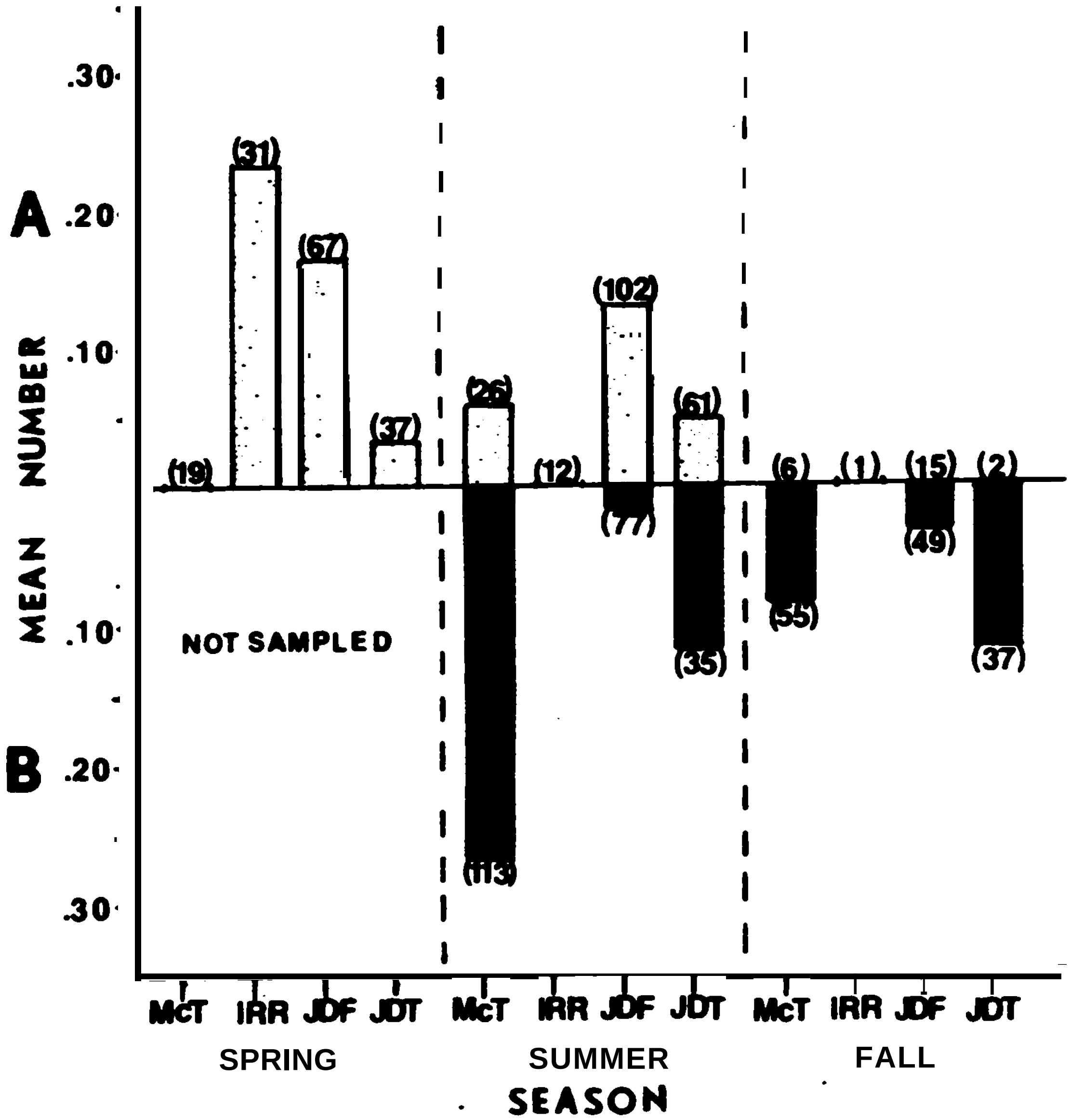

Figure 6. Mean number of juvenile salmon and steelhead in digestive tracts of northern squawfish by station and season in John Day Reservoir and tailrace, 1982. Mean numbers are shown for inside the restricted zone (A) and outside the restricted zone (B). Symbols for stations are McNary tailrace, McT; Irrigon, TRR; John Day forebay, JDF; John Day tailrace, JDT. Sample sizes are in parentheses.

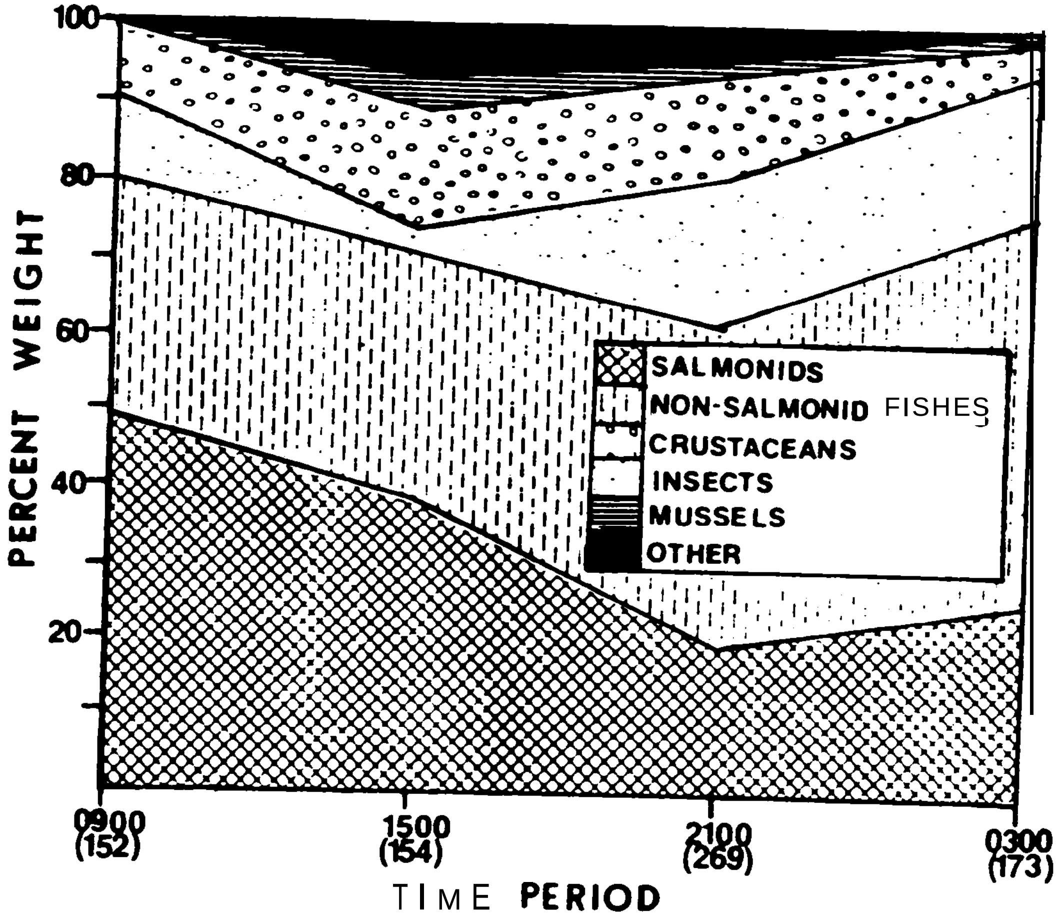

Figure 7. Percent weight of major food items and time of capture for northern squawfish collected in John Day Reservoir and tailrace, April to December 1982. Time Periods are midpoints of six hour intervals. Sample sizes are in parentheses.

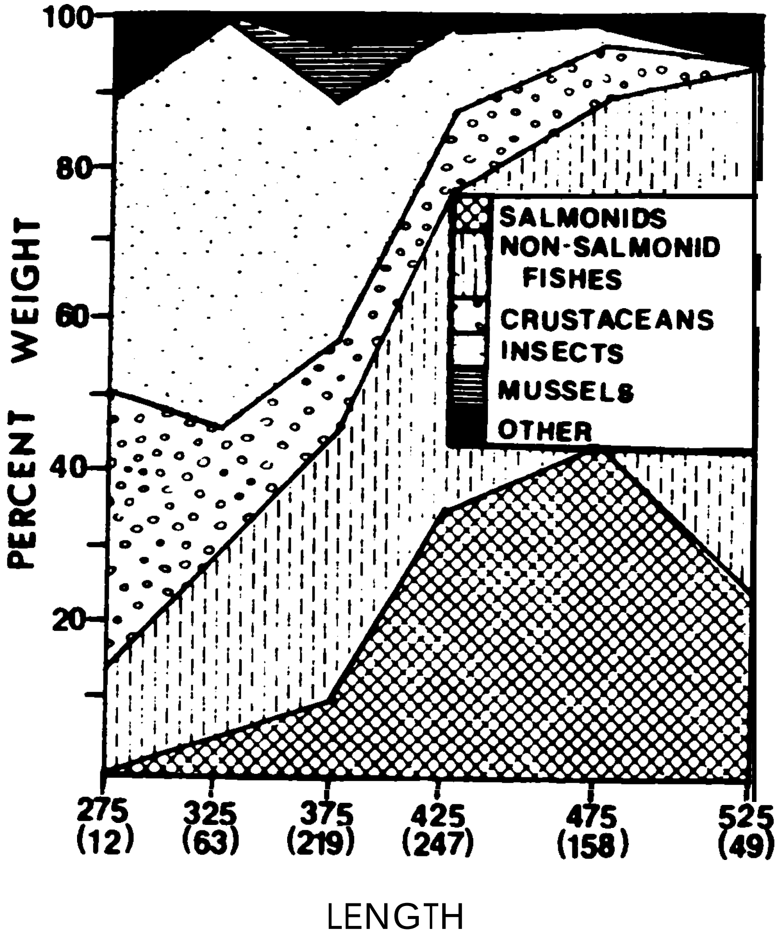

Figure 8. Percent weight of major food items and lengths of northern squawfish collected in John Day Reservoir and tailrace, April to December 1982. Lengths are midpoints of 50 mm intervals. Sample sizes are in parentheses.

Food Habits of Walleye

Stomach contents of 213 walleye, collected from April to December, were analysed. The majority of these fish (182) were captured during May and June. Walleye examined ranged in length from 201 to 750 mm. Thirty-nine (18.3%) of the stomachs examined were empty. Estimated overall and mean efficiency for 18 stomach pumped walleye was 100%.

A variety of food items consisting of fish, crustaceans, and insects composed the diet of walleye from John Day Reservoir and tailrace (Appendix 2). Mean number, percent occurrence, and percent number and weight of these groups are given in Table 7.

Suckers, chiselmouth, sculpins, salmonids, northern squawfish, and peamouth were the most important food items by weight in the diet of walleye. As a group, fish accounted for 98.9% by weight and 13% by number of food items. Crustaceans were the most numerous dietary component, contributing 79.0% by number, but less than 1.0% by weight. Insects comprised 7.6% and 0.6% by number and weight of food items, respectively.

Salmonids were the fourth most important food item in the walleye diet, accounting for 11.5% by weight and 3.8% by number of food items. Subyearling chinook salmon represented 80.0% of the identified salmonids, whereas yearling chinook accounted for 20.0%; no steelhead trout were identified in stomach contents.

Fish were the most important food item of walleye during spring accounting for about 99% of the total food weight at all stations

Table 7. Mean number, percent occurrence, percent number, and percent weight of food items in stchs of 213 walleye (>200mm) collected in John Day Reservoir and tailrace, April to September 1982.

Food item	Mean number	Percent occurrence	Percent number	Percent weight
CRUSTACEANS	7.60	22.4	79.0	0.5
Cladocera	4.53	3.4	47.1	0.1
Hysidacea				
Neoaysis mercedis	0.89	9.8	9.3	0.4
Copepoda	1.73	2.4	17.9	<0.1
Amphipoda				
Anisogammarus spp.	0.02	1.5	0.2	<0.1
Corophium spp.	0.42	5.9	4.4	<0.1
Decapoda	<0.01	0.5	0.1	to.1
INSECTS	0.72	24.4	7.6	0.6
Ephemeroptera	0.30	13.7	3.2	0.6
Orthoptera	to.01	0.5	0.1	<0.1
Hemiptera	0.00	0.5	0.1	<0.1
Homoptera	0.01	0.5	0.1	0.1
Diptera	0.38		3.9	<0.1
Hymenoptera	0.01	0.5	0.2	<0.1
FISH	1.27	67.3	13.4	98.9
Salmonidae	0.37	23.4	3.8	11.5
Oncorhynchus tshawytscha	0.24		2.5	8.3
Unidentified Salmonidae	0.13		1.3	3.2
Cyprinidae				
Acrocheilus alutaceas	0.15	11.7	1.6	19.5
Hylocheilus caurinus	0.04	2.9	0.5	9.4
Ptychocheilus oregonensis	0.09	7.3	0.9	9.6
Richardsonius balteatus	<0.01	0.5	0.1	<0.1
Catostomidae				
Catostomus spp.	0.13	11.2	1.3	30.5
Percopsidae				
Percopsis transaontana	0.02	1.5	0.3	1.7
Cottidae				
Cottus spp.	0.28	15.6	2.9	14.8
Unidentified non-salmonidae	0.19	17.1	2.0	1.9

(Table 8). However, relative importance of each prey species varied among stations. At John Day tailrace, chiselmouth and suckers were the most important fish in the diet, accounting for 33.0% and 21.3% by weight of -food items, respectively. Salmonids and sculpins dominated at Irrigon, representing 51.4% and 37.8% by weight, respectively. At McNary tailrace, suckers comprised 51.8% and sculpins 23.3% by weight of food items. Stomachs of three walleye collected at John Day forebay were empty.

Although salmonids dominated by weight at Irrigon, the mean number consumed per walleye was equal to that at John Day tailrace (0.55); percent occurrence was 34.0% at John Day tailrace, and 30.0% at Irrigon. Mean number and percent occurrence of salmonids in the diet of walleye at McNary tailrace was 0.13 and 10.7%, respectively.

Fish comprised about 99% by weight of food items in the diet of walleye throughout the 24-hour period (Fig. 9). However, importance of salmonids in the diet varied with time of capture. Salmonids did not contribute to the diet from 0600 to 1200 hours, accounted for 0.4% by weight from 1200 to 1800, 9.9% from 1800 to 2400 hours, and 22.6% from 2400 to 0600 hours. Mean number of salmonids consumed per walleye was greatest from 2400 to 0600 hours when 0.60 salmonids were consumed, followed by the 1800 to 2400 time interval when 0.53 were consumed per walleye (Fig. 10).

Importance of major food items in walleye stomach contents varied with length of predator (Fig. 111. Salmonids and crustaceans were

Table 8. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of walleye by station in John Day Reservoir and tailrace, April to June 1982. Sample sizes are in parentheses.

Station	Food item	Mean number	Percent occurrence	Percent number	Percent weight
McNary tailrace (56)	Crustaceans	1.39	16.1	46.7	0.1
	Insects	0.39	23.2	13.1	0.5
	Fish	1.20	67.9	40.1	99.4
	Salmonidae	0.13	10.7	4.1	9.2
	Other food	0.00	0.0	0.0	0.0
Irrigon (20)	Crustaceans	64.20	60.0	96.1	0.7
	Insects	1.20	40.0	1.7	0.1
	Fish	1.45	70.0	2.1	99.1
	Salmonidae	0.55	30.0	0.8	51.4
	Other food	0.10	10.0	0.1	to.1
John Day tailrace (103)	Crustaceans	1.80	21.3	48.6	0.6
	Insects	0.53	18.4	14.3	0.0
	Fish	1.37	67.0	36.9	99.4
	Salmonidae	0.55	34.0	14.9	8.5
	Other food	0.01	1.0	0.2	<0.1

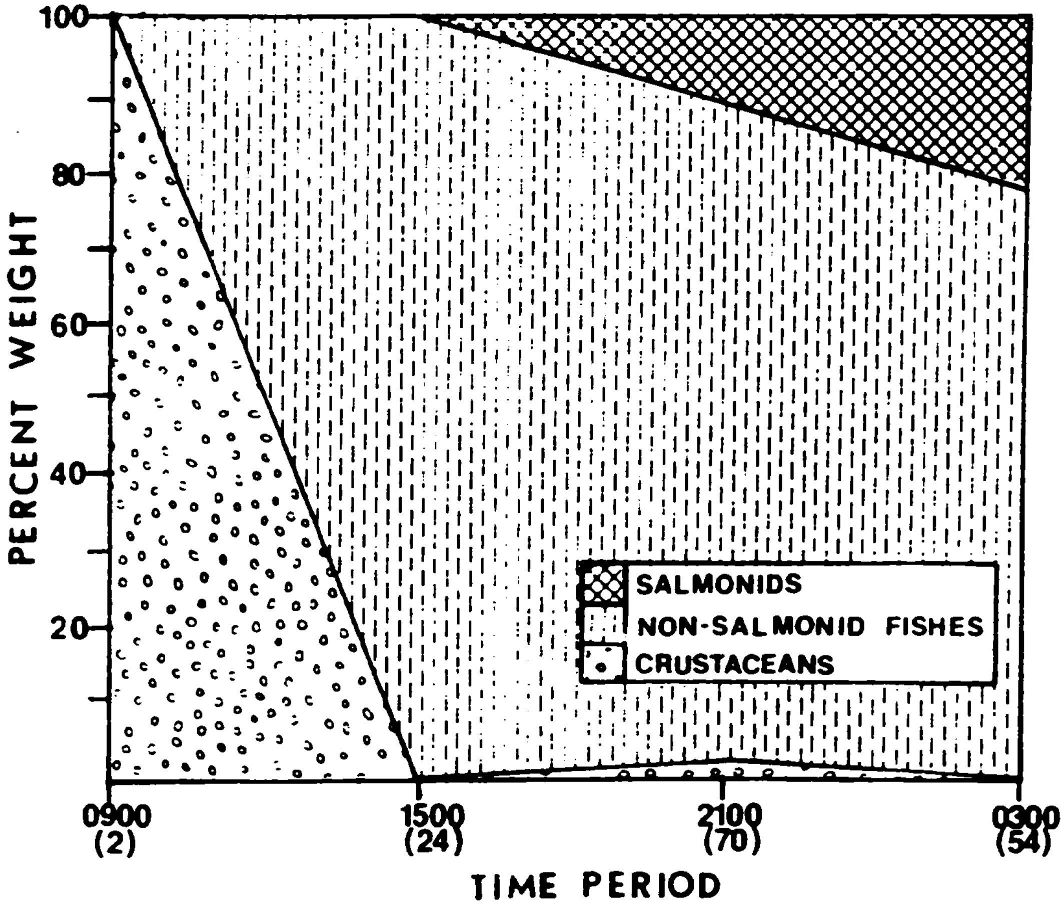

Figure 9. Percent weight of major food items and time of capture for walleye collected in John Day Reservoir and tailrace, May to June 1982. Time periods are midpoints of six hour intervals. Sample sizes are in parentheses.

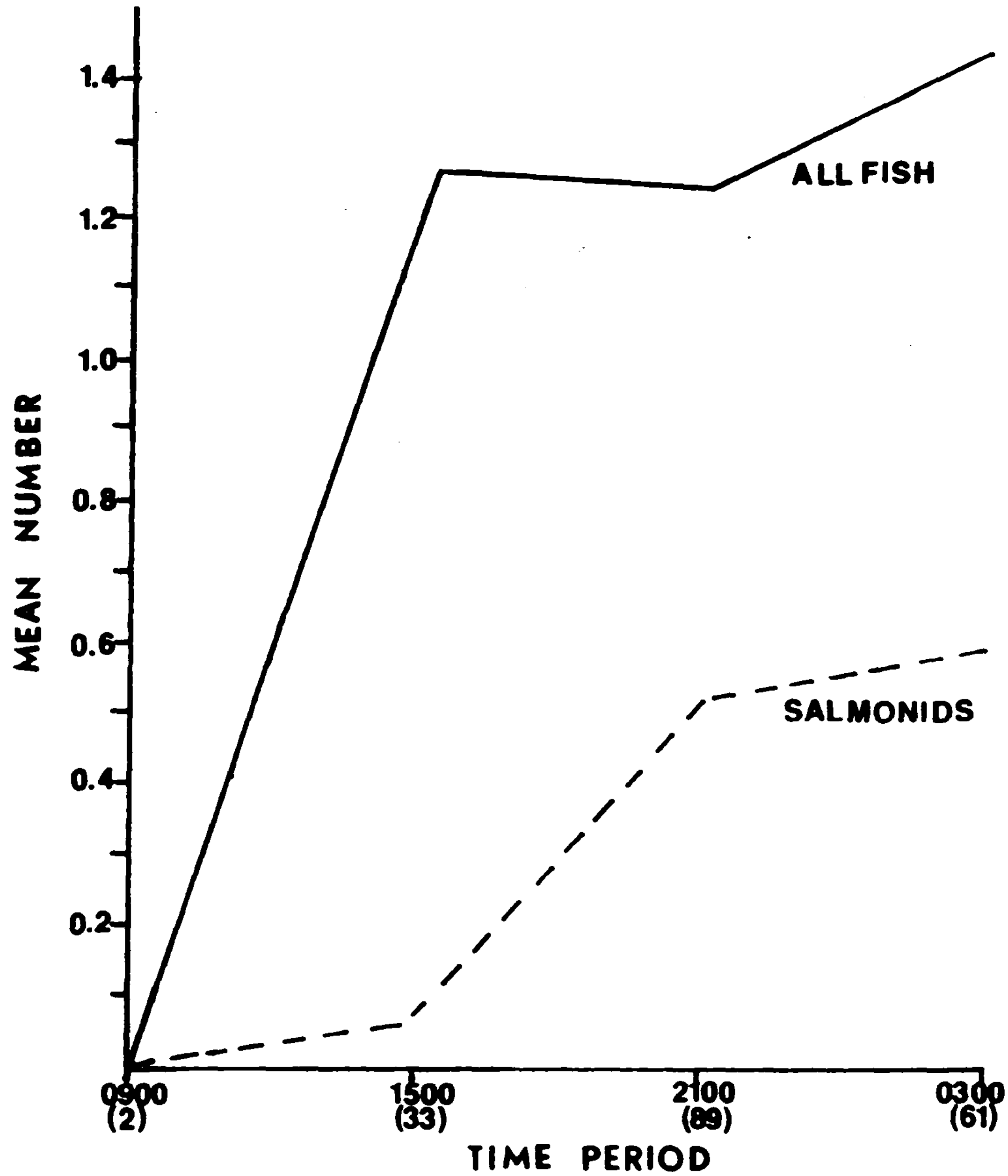

Figure 10. Mean number of all fish and juvenile salmonids consumed and time of capture for walleye collected in John Day Reservoir and tailrace, May to June 1982. Time periods are midpoints of six hour intervals. Sample sizes are in parentheses.

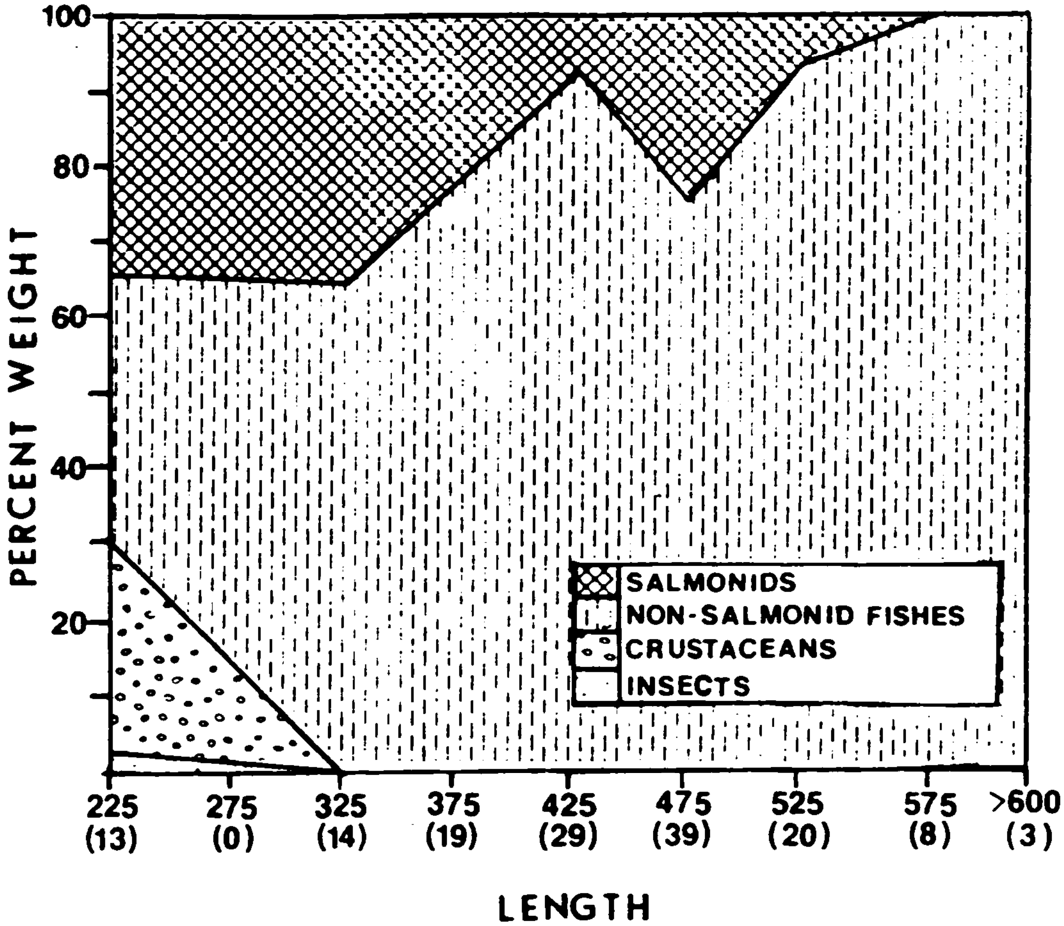

Figure 11. Percent weight of major food items and lengths of walleye collected in John Day Reservoir and tailrace, May to June 1982. Lengths are midpoints of 50 mm intervals. Sample sizes are in parentheses.

the most important food items in stomach contents of smaller walleye, but with an increase in size crustaceans and salmonids decreased in importance. Crustaceans were not found in walleye longer than 300 mm. Salmonids comprised approximately 35% of the total weight of food items in the diet of walleye 200 to 350 mm in length, but 0% by weight for fish greater than 550 mm long. Fishes other than salmonids increased in importance in the diet with an increase in walleye length. Fish other than salmonids increased from 35.8% by weight in walleye 200 to 250 mm to 100% in fish longer than 600 mm.

Mean number of salmonids consumed by walleye generally decreased as length of walleye increased. Walleye 200 to 250 mm long contained 0.63 salmonids per predator, whereas fish 300 to 350, 350 to 500, and 500 to 550 mm contained about 0.89, 0.40 and 0.16 salmonids per predator, respectively.

Food Habits of Smallmouth Bass

Stomach contents from 629 smallmouth bass collected from April to December were analysed. Eighty-six (13.7%) of these stomachs were empty. Smallmouth bass examined ranged in length from 151 to 452 mm. Estimated overall and mean efficiency for 40 stomach pumped smallmouth bass was 85.4% and 88.9%, respectively. Efficiency was improved by using foreceps to aid in removal of crayfish, the most difficult food group to pump. Analysis of station, seasonal, and diel effects on feeding was restricted to April to September because no stomachs were collected at three of the four stations during fall.

Taxonomic groups found in the diet of smallmouth bass are given in Appendix 3. Mean number, percent occurrence, and percent by number and weight of these groups are summarized in Table 9. Sculpins, crayfish, and other fishes were the most important food items in the diet of smallmouth bass. Sculpins accounted for 36.2% and crayfish 25.9% by weight.

Fish and crustaceans represented 72.3% and 26.6% of the total food weight, respectively. Crustaceans were the most abundant food, accounting for 69.3% by number of food items; fish contributed 10.5% by number. Insects represented 19.4% of the food items by number, but contributed little by weight (1.0%). Salmonids comprised a small part of the smallmouth bass diet, representing 2.3% by weight and 0.4% by number of food items.

Based on percent weight, fish dominated the diet throughout the reservoir. However, relative importance of major food items varied among stations (Table 10). Fish accounted for 96% and 97% by weight of food items in the stomach contents of smallmouth bass collected at McNary tailrace and Irrigon, respectively. Importance of fish in the diet of smallmouth bass collected at John Day tailrace and forebay was lower because of increased consumption of crayfish; fish represented 56.4% and 53.4%, and crayfish, 33.9% and 45.5% by weight of food items, respectively.

Table 9. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of 629 smallmouth bass (>150 mm) collected in John Day Reservoir and tailrace, April to December 1982.

Food item	Mean number	Percent occurrence	Percent number	Percent weight
MUSSELS				
Corbicula manilensis	0.01	0.8	0.1	<0.1
CRUSTACEANS	7.19	49.8	69.3	26.6
Cladocera	4.86	3.5	46.9	<0.1
Mysidacea	0.52	1.3	5.0	0.4
Copepoda	0.04	1.3	0.4	<0.1
Isopoda	<0.01	0.5	0.1	<0.1
Amphipoda				
Anisogammarus spp.	0.46	15.1	4.5	0.1
Corophium spp.	0.91	15.3	8.8	0.1
Decapoda				
Pacifastacus leniusculus	0.40	31.3	3.8	25.9
INSECTS	2.02	40.7	19.4	1.0
Ephemeroptera	0.22	9.5	2.1	0.2
Odonata	0.01	1.0	0.1	0.1
Orthoptera	<0.01	0.2	to.1	to.1
Thysanoptera	to.01	0.2	to.1	to.1
Hemiptera	0.02	1.7	0.2	to.1
Homoptera	0.01	0.8	0.1	to.1
Coleoptera	0.02	1.6	0.2	0.3
Trichoptera	0.02	1.6	0.2	<0.1
Diptera	0.63	10.5	6.1	<0.1
Hymenoptera	0.99	7.0	9.6	0.3
Unidentified insects	0.08	7.3	0.8	0.1
FISH	1.09	47.7	10.5	72.3
Clupeidae				
Alosa sapidissima	to.01	0.2	to.1	to.1
Salmonidae	0.05	3.7	0.4	2.3
Oncorhynchus tshawytscha	to.01	3.6	0.1	0.4
Unidentified salmonids	0.04	3.0	0.4	2.0
Cyprinidae				
Acrocheilus alutaceus	0.05	3.7	0.5	9.5
Mylocheilus caurinus	0.04	3.0	0.4	2.2
Ptychocheilus oregonensis	0.14	4.9	1.3	5.1
Catostomidae	0.09	7.2	0.9	13.3
Centrarchidae	<0.01	0.5	0.1	0.5
Cottidae				
Cottus spp.	0.28	18.9	2.7	36.2
Unidentified non-salmonidae	0.45	15.7	4.3	3.0
OTHER FOOD	0.06	2.5	0.5	0.2

Table 10. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of smallmouth bass by station in John Day Reservoir and tailrace, April to September 1982. Sample sizes are in parentheses.

Station	Food item	Mean number	Percent occurrence	Percent number	Percent weight
McNary tailrace (47)	Crayfish	0.10	10.0	2.4	2.4
	Other crustaceans	0.76		18.8	0.5
	Insects	1.90	56.0	47.0	1.3
	Fish	1.28	66.0	31.8	95.8
	Salmonidae	0.00	0.0	0.0	0.0
	Other food	0.00	0.0	0.0	0.0
Irrigon (171)	Crayfish	0.11	8.2	0.6	1.2
	Other crustaceans	13.75		79.5	0.2
	Insects	1.43	46.6	8.2	1.4
	Fish	1.85	63.0	10.7	97.0
	Salmonidae	0.11	8.2	0.6	5.8
	Other food	0.13	4.3	1.0	0.2
John Day forebay (269)	Crayfish	0.67	51.5	9.5	45.5
	Other crustaceans	3.17		45.3	0.3
	Insects	2.63	34.9	37.7	0.7
	Fish	0.48	32.7	6.9	53.4
	Salmonidae	0.16	1.6	0.2	0.2
	Other food	0.02	1.9	0.6	0.1
John Day tailrace (38)	Crayfish	0.33	33.3	2.8	33.9
	Other Crustaceans	8.77		76.4	9.0
	Insects	1.33	51.3	11.5	0.7
	Fish	1.08	59.0	9.3	56.4
	Salmonidae	0.00	0.0	0.0	0.0
	Other food	0.00	0.0	0.0	0.0

No salmonids were found in the diet of smallmouth bass collected at McNary and John Day tailraces but they represented 0.2% of the total food weight at John Day forebay and 5.8% at Irrigon. A mean of 0.02 and 0.11 salmonids per smallmouth bass were consumed at the forebay and Irrigon, respectively.

At McNary tailrace and Irrigon, where few crayfish were found in the diet, there was little or no change in percent weight of fish (Table 11) from spring to summer (97.9% to 91 .l% and 96.7% to 94.4%, respectively). However, at John Day forebay and tailrace importance of food items varied between seasons. At these stations, crayfish increased in importance from spring to summer (40.4% to 52.0% and 20.6% to 40.3% by weight, respectively1 and fish decreased in importance (58.6% to 46.1% and 66.9% to 51.5% by weight, respectively). Sculpins were the most important fish in the diet of smallmouth bass at all stations during spring and summer, but the relative importance of other fishes varied by station and season.

Importance of salmonids in the diet of smallmouth bass at John Day forebay and Irrigon varied between seasons. Percent weight of salmonids decreased from 7.8% to 3% between spring and summer at Irrigon and from 0.3% to 0% at John Day forebay. Mean number of salmonids consumed per smallmouth bass decreased during spring to summer from 0.14 to 0.08 and 0.03 to 0.02 at Irrigon and John Day forebay, respectively.

Table 11. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of smallmouth bass (>150 mm) by station in John Day Reservoir and tailrace during spring and summer, 1982. Sample sizes are in parentheses.

Station	Food item	Spring Mean number	Spring Percent occurrence	Spring Percent number	Spring Percent weight	Summer Mean number	Summer Percent occurrence	Summer Percent number	Summer Percent weight
McNary tailrace (26)	Crayfish	0.04	3.8	0.9	0.7	0.17	16.7	4.2	6.5
	Other Crustaceans	1.27		30.8	0.6	0.21		5.2	0.0
	Insects	1.31	57.7	31.9	0.8	2.54	54.2	64.3	2.4
	Fish	1.50	69.2	36.4	97.9	1.04	62.5	26.3	91.1
	Salmonidae	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
	Other Food	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
Irrigon (116)	Crayfish	0.12	8.6	3.6	1.0	0.09	7.6	0.2	1.6
	Other Crustaceans	0.73		21.9	0.1	30.15		86.5	0.3
	Insects	1.35	45.7	40.5	2.0	1.52	47.8	4.3	0.5
	Fish	1.02	66.6	30.4	96.7	2.91	75.0	8.3	97.4
	Salmonidae	0.14	12.9	4.1	7.8	0.08	5.4	0.2	3.0
	Other food	0.11	1.7	4.6	0.2	0.17	8.7	0.7	0.2
John Day forebay (193)	Crayfish	0.60	45.6	16.0	40.4	0.72	57.4	3.8	52.0
	Other Crustaceans	1.71		31.0	0.3	12.00		63.3	0.5
	Insects	2.01	31.1	44.2	0.6	5.47	45.0	28.8	1.3
	Fish	0.38	37.7	8.3	58.6	0.74	40.3	3.8	46.1
	Salmonidae	0.03	2.6	0.6	0.3	0.02	1.6	0.0	0.0
	Other food	0.02	1.6	0.5	0.1	0.03	3.1	0.3	0.1
John Day tailrace (22)	Crayfish	0.24	23.5	2.4	20.6	0.41	40.9	3.1	40.3
	Other Crustaceans	7.24		75.5	10.9	9.95		76.3	7.6
	Insects	1.47	58.8	15.3	1.1	1.23	45.5	9.5	0.6
	Fish	0.59	41.2	6.1	66.9	1.45	72.7	11.1	51.5
	Salmondiae	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
	Other food	0.06	5.9	0.7	0.5	0.00	0.0	0.0	0.0

Changes in food composition over the die1 period were observed (Fig. 12). Crayfish accounted for 66.8% by weight of food items found in smallmouth bass collected at John Day tailrace and forebay between 0600 and 1200 hours, but decreased in importance throughout the rest of the day, contributing only 27.8% by weight between 2400 and 0600 hours. In contrast, fish represented 28.2% by weight of food items between 0600 and 1200 hours and 70.5% by weight of food items between 2400 and 0600 hours. At McNary tailrace and Irrigon, fish decreased little in importance during the 24-hour period.

The importance of salmonids in the diet varied between stations and throughout the day. Percent weight of salaonids in the diet of smallmouth bass at Irrigon was lowest (0%) between 0600 and 1200 hours and greatest (11.4%) between 2400 and 0600 hours. At the forebay, salmonids accounted for 1 .0% of the total food weight between 0600 and 1200 hours and 0.5% between 1200 and 1800.

Mean number of salmonids consumed per smallmouth bass at Irrigon ranged from 0.14 in the 1800 to 2400 hour time period to zero between 0600 and 1200 hours (Fig. 13). The greatest number of salmonids consumed per smallmouth bass at the forebay was 0.03 from 1200 to 1800.

Smallmouth bass collected from McNary tailrace and Irrigon were more piscivorous at all lengths than those from John Day tailrace and forebay (Fig. 14). Fish represented 85.8% by weight of food items for fish 300 to 350 mm long. For fish longer than 350 mm, crustaceans and insects again increased in importance, but this may reflect the small

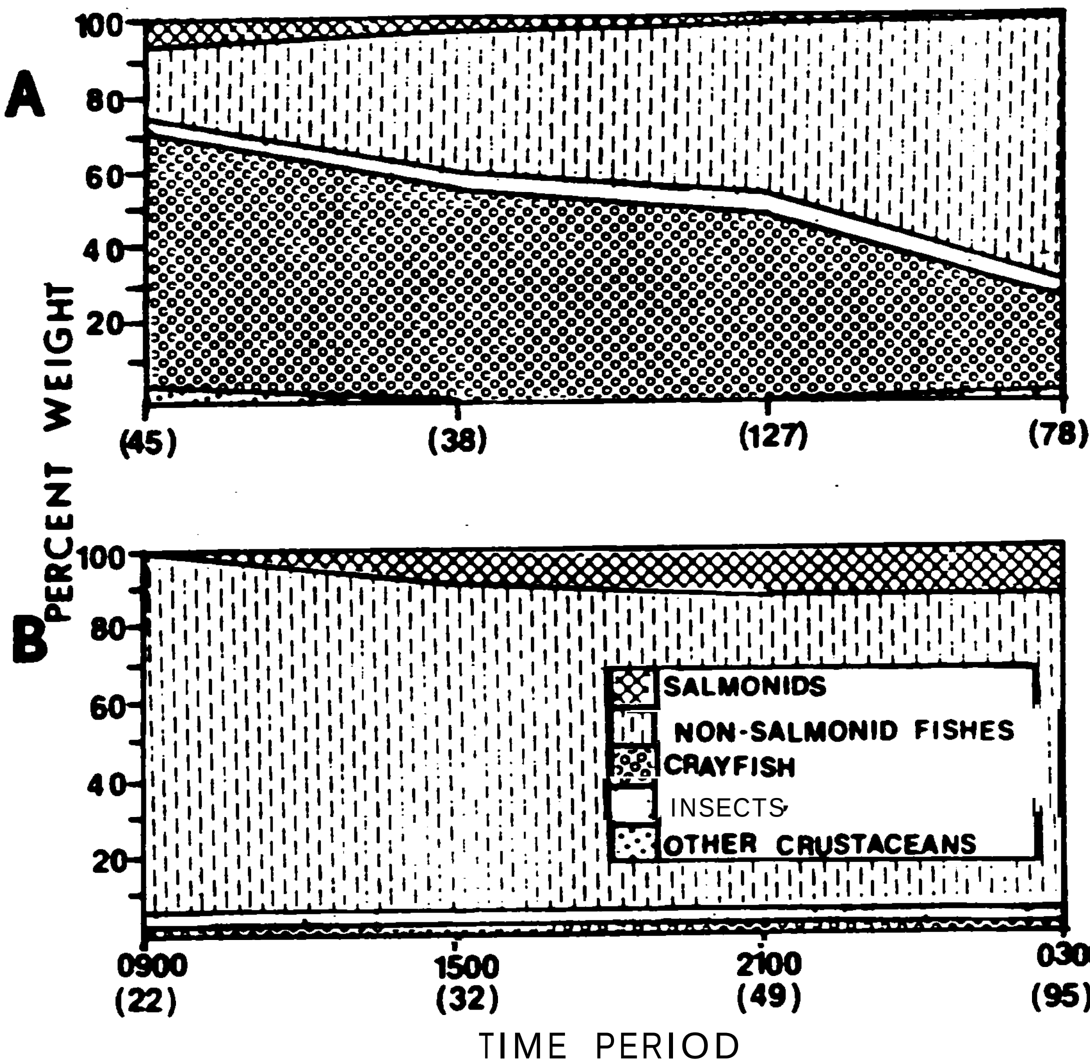

Figure 12. Percent weight of major food items and time of capture for smallmouth bass collected in John Day Reservoir and tailrace, April to September 1982. Percent weights are grouped for the John Day forebay and tailrace (A) and for the McNary tailrace and Irrigon (B). Time periods are midpoints of six hour intervals. Sample sizes are in parentheses.

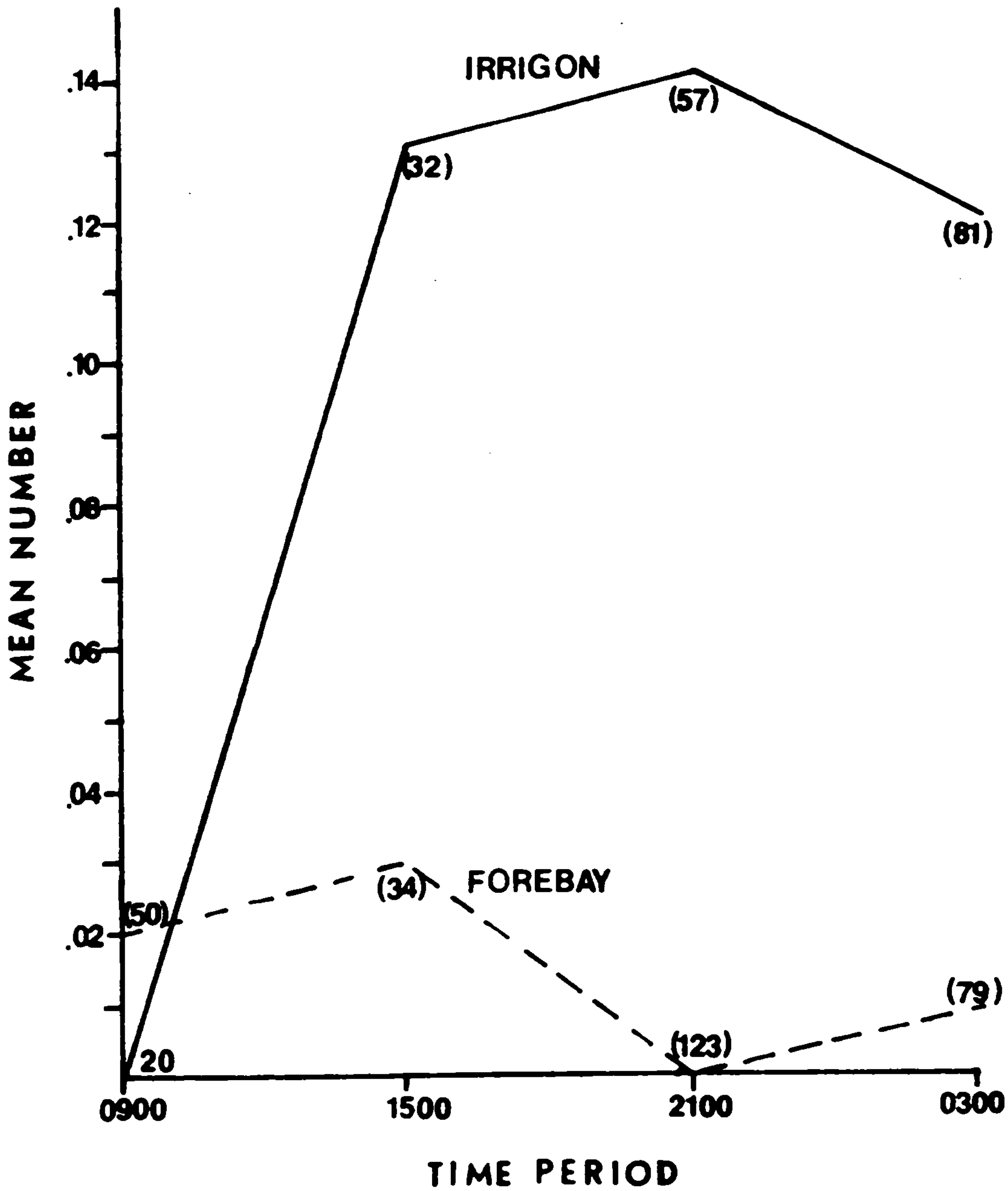

Figure 13. Mean number of juvenile salmonids consumed and time of capture for smallmouth bass collected at Irrigon and the John Day forebay, April to September 1982. Time periods are midpoints of six hour intervals. Sample sizes are in parentheses.

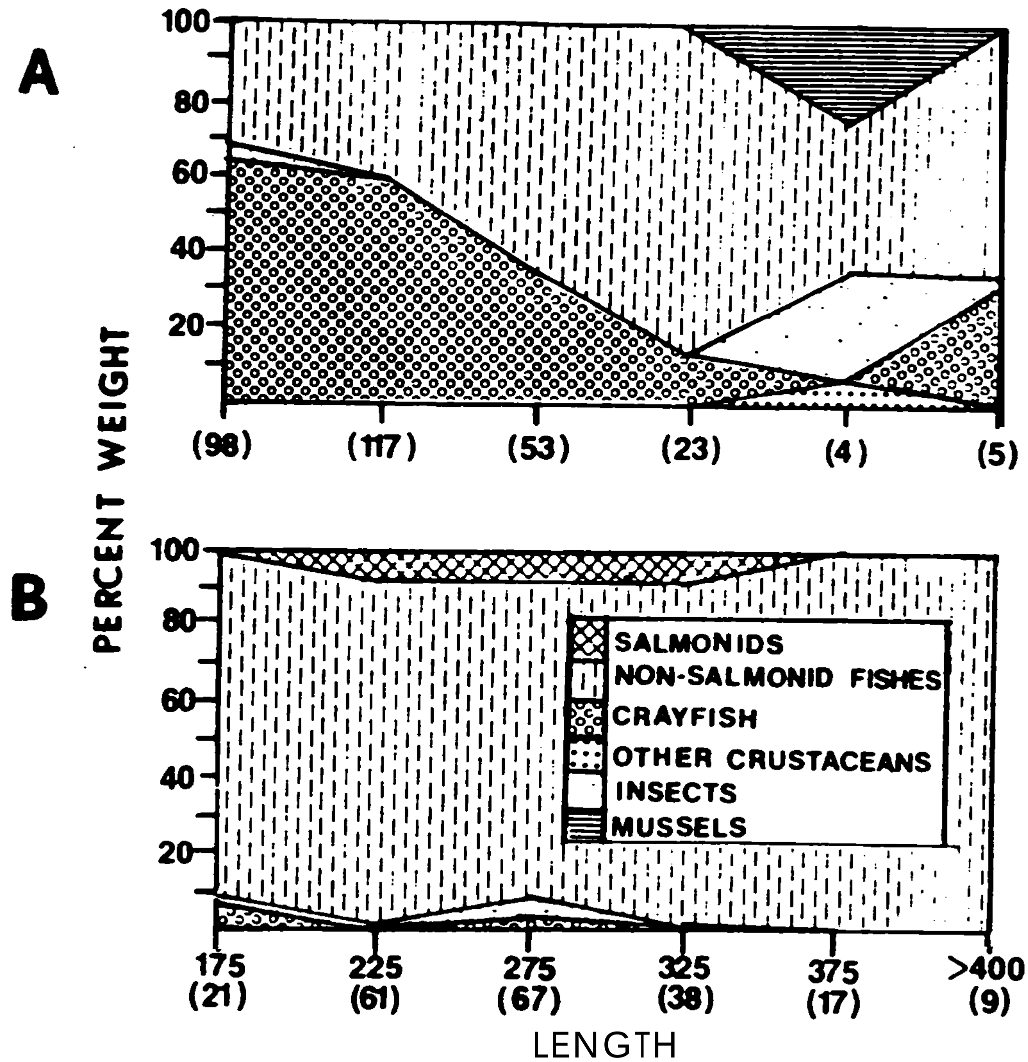

Figure 14. Percent weight of major food items and lengths of smallmouth bass collected in John Day Reservoir and tailrace, April to October 1982. Percent weights are grouped for John Day forebay and tailrace (A) and McNary tailrace and Irrigon (B). Lengths are midpoints of 50 mm intervals. Sample sizes are in parentheses.

sample size. At McNary tailrace and Irrigon, where crayfish were not common in the diet, fish accounted for 91.2% to 99.7% by weight for fish of all lengths. Crayfish were the most important food in the diet of 150 to 200 mm long smallmouth bass from John Day tailrace and forebay, comprising 64.8% by weight. As smallmouth bass lengths increase, the importance of crayfish decreased and fish increased.

Salmonids were found in the stomachs of smallmouth bass 150 to 343 mm in length. However, smallmouth bass 200 to 350 mm in length consumed the most salmonids at Irrigon where the mean number of salmonids eaten per fish was 0.17 for fish 200 to 250 mm long, 0.12 for fish 250 to 300 mm long, and 0.16 for fish 300 to 350 mm long. A mean of 0.03 and 0.08 salmonids were consumed per smallmouth bass 200 to 250 mm long and 300 to 350 mm long, respectively, at the forebay.

Food Habits of Channel Catfish

Stomach contents from 69 channel catfish were analyzed; none were empty. Stomachs examined were from fish ranging in length from 170 to 746 mm; the majority (76%) were 322 to 598 mm. A complete list of taxonomic groups identified in stomachs can be found in Appendix 4.

Crayfish were the dominant food by weight (62.6%) but mean number per individual (1.32) and percent number (2.9%) were quite low (Table 12). Corophium spp. were the most abundant food item in channel

Table 12. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of 69 channel catfish (>150 mm) collected in John Day Reservoir, June to October 1982.

Food item	Mean number	Percent occurrence	Percent number	Percent weight
MUSSELS				
Corbicula manilensis	0.12	10.1	0.3	0.3
CRUSTACEANS	42.75	55.1	95.0	67.6
Amphipoda				
Anisogammarus spp.	0.01	1.5	<0.1	<0.1
Corophium spp.	41.42	23.2	92.1	5.0
Decapoda				
Pacifastacus leniusculus	1.32	39.1	2.9	62.6
INSECTS	1.84	33.3	4.1	3.0
Ephemeroptera	0.48	20.3	1.1	2.9
Odonata	0.01	1.5	<0.1	0.1
Coleoptera	0.04	2.9	0.1	<0.1
Trichoptera	0.12	7.3	0.3	<0.1
Diptera	1.16	15.9	2.6	<0.1
Hymenoptera	0.03	2.9	0.1	<0.1
FISH	0.26	18.8	0.6	29.1
Salmonidae				
Oncorhynchus tschawytscha	0.03	1.5	0.1	0.1
Cyprinidae				
Cyprinus carpio	0.06	5.8	0.1	0.7
Acrocheilus alutaceus	0.01	1.5	to.1	19.3
Catostomidae				
Catostonus spp.	0.09	5.8	0.2	5.4
Centrarchidae	0.01	1.5	<0.1	<0.1
Cottidae				
Cottus spp.	0.03	2.9	0.1	2.6
OTHER FOOD	0.01	1.5	to.1	<0.1

catfish stomachs (92-1%) but contributed little by weight (5.0%). Fish were the second most important food by weight (29.1%) but were infrequently consumed (0.26). Carp and suckers were the most numerous fish identified in the stomachs. Only two salmonids were identified; both were subyearling chinooks.

While the mean number of crayfish in stomachs of channel catfish was only 0.68 at John Day forebay they were the dominant food item by weight (52.0%) (Table 13). Fish were also important by weight (39.6%) but mean number was low (0.18). Corophium spp. were numerically dominant (94.4%) but 99% came from two of the 40 fish examined. Two salmonids were found in the stomach of a single channel catfish collected in July. The channel catfish was 499 mm in length and weighed 1,427 gms.

Crayfish were the dominant food item at Irrigon, comprising 69.3% and 95.7% of the tntal contents by number and weight, respectively. Again at Irrigon, fish followed crayfish in importance by weight (3.8%) but were low in number (4.0%). Corophium were of little importance by weight (<0.1%) or number (17.3%) at Irrigon.

Fish replaced crayfish as the dominant food item by weight at McNary tailrace (40.4%) with crayfish second (37.5%). However, mean number of crayfish per stomach was 0.67 as compared to 0.44 for fish. As at John Day forebay, Corophium were numerically dominant at McNary tailrace (92.0%) but a large number (68%) came from one fish.

Table 13. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of channel catfish by station in John Day Reservoir, June to October 1982. Sample sizes are in parentheses.

Station	Food item	Mean number	Percent occurrence	Percent number	Percent weight
McNary tailrace (18)	Crustaceans	31.50	72.2	94.0	42.6
	Corophium spp.	30.83	38.9	92.0	5.1
	Crayfish	0.67	44.4	1.9	37.5
	Insects	1.39	44.4	4.1	15.9
	Fish	0.44	27.8	1.3	40.4
	Salmonidae	0.00	0.0	0.0	0.0
	Other food	0.17	11.1	0.4	0.9
Irrigon (11)	Crustaceans	5.91	72.7	86.6	95.8
	Corophium spp.	1.18	18.2	17.3	to.1
	Crayfish	4.73	63.6	69.3	95.7
	Insects	0.45	18.1	6.6	to.1
	Fish	0.27	18.1	4.0	3.8
	Salmonidae	0.00	0.0	0.0	0.0
	Other food	0.18	18.2	0.2	0.2
John Day forebay (40)	Crustaceans	57.95	42.5	95.5	59.7
	Corophium spp.	57.28	17.5	94.4	7.7
	Crayfish	0.68	30.0	1.1	52.0
	Insects	2.43	32.5	3.9	0.5
	Fish	0.18	15.0	0.2	39.6
	Salmonidae	0.05	2.5	<0.1	0.1
	Other food	0.10	10.0	0.4	0.1

Analysis of seasonal feeding of channel catfish was restricted to John Day forebay because numbers of stomachs collected at other stations were too low to make comparisons. Data from fish collected at John Day forebay were compared on a monthly basis.

Crayfish were the dominant food item in June by weight (98.2%) but the mean number per channel catfish was only 0.67 (Table 14). Insects (primarily Chironomidae) and Corophium combined accounted for 90% of food items by number but only 2% by weight. In July, fish replaced crayfish as the dominant food item by weight. Crayfish contributed 38.1% by weight and 0.8% by number with Corophium becoming the most important food item by number (96.6%). Insects and Corophium were the only food items that could be identified in channel catfish stomachs collected in August. Insects contributed 93.7% by number and 99.6% by weight. Corophium occurred in one stomach and contrubuted 0.3% by weight. Crayfish were again important in diets of channel catfish in September, contributing 60.0% by number and 99.9% by weight.

Crayfish were the dominant food item in the stomach contents during the dusk and dawn time periods (Fig. 15) but contributed 25.3% more to the total weight of food items consumed at dusk. Conversely, the percent weight of fish in the diet increased 32.3% from dusk to dawn. Percent by weight of other major food groups was relatively uniform between dusk and dawn.

Insects and Corophium were the primary food items consumed by channel catfish less than 250 mm in length (Fig. 16). Corophium

Table 14. Mean number, percent occurrence, percent number, and percent weight of food items in stomachs of channel catfish by month in John Day forebay, June to September 1982. Sample sizes are in parentheses.

Month	Food item	Mean number	Percent occurrence	Percent number	Percent weight
June					
(6)	Crustaceans	3.33	50.0	37.7	98.5
	Corophium spp.	2.67	33.3	30.1	0.2
	Crayfish	0.67	16.7	7.5	98.2
	Insects	5.33	50.0	60.3	1.4
	Fish				
	Other food	0.17	16.7	1.8	<0.1
July					
(21)	Crustaceans	3.33	47.6	97.5	47.6
	Corophium spp.	2.67	14.3	96.6	10.0
	Crayfish	0.95	38.1	0.8	37.5
	Insects	2.33	28.6	2.0	0.3
	Fish	0.33	28.6	0.2	52.0
	Other food	0.10	9.5	<0.1	<0.1
August					
(5)	Crustaceans	0.20	20.0	6.2	0.3
	Corophium spp.	0.20	20.0	6.2	0.3
	Crayfish				
	Insects	3.00	60.0	93.7	99.6
	Fish			-	
	Other food			-	
September					
(6)	Crustaceans	0.67	50.0	80.0	99.9
	Corophium spp.	0.17	16.7	20.0	<0.1
	Crayfish	0.50	50.0	60.0	99.9
	Insects				
	Fish				
	Other food	0.17	16.2	20.0	<0.1

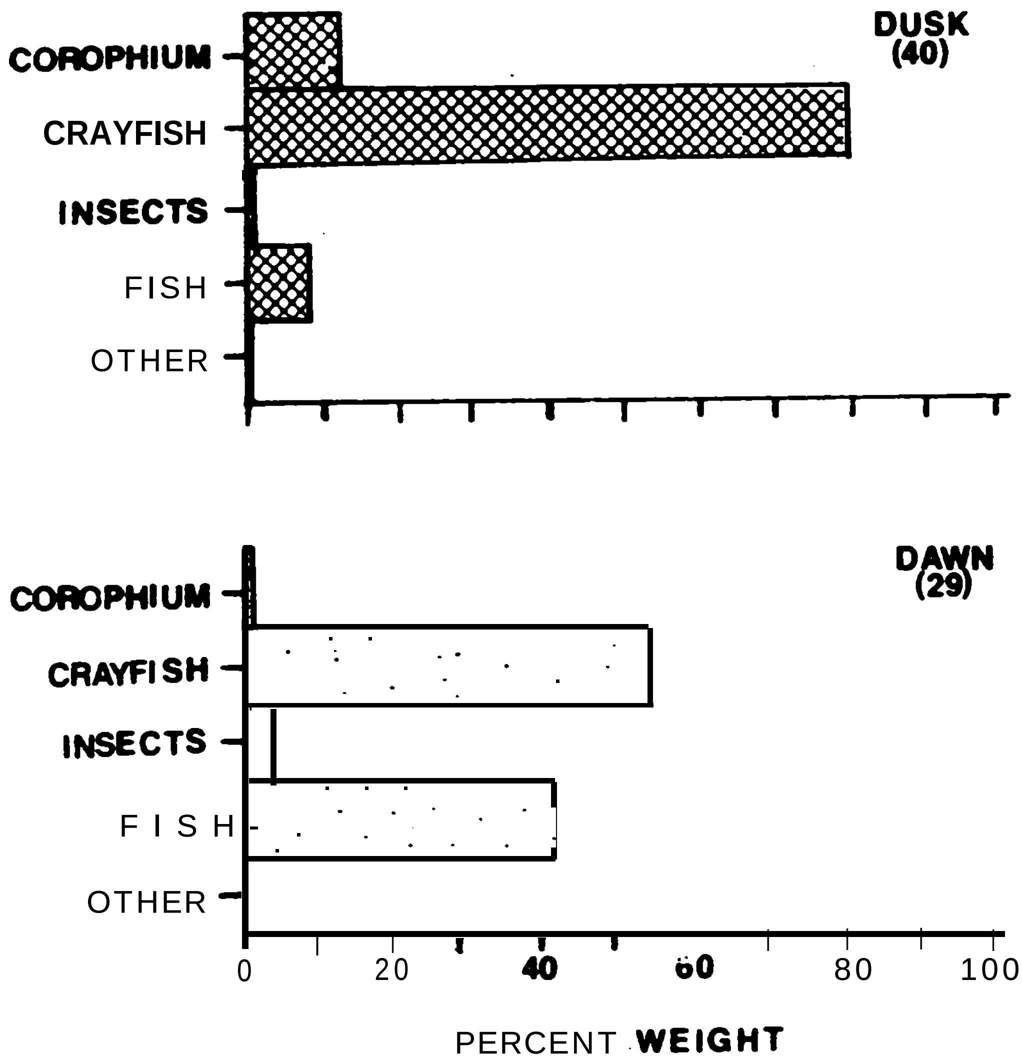

Figure 15. Percent weight of major food items consumed by channel catfish collected at dusk and dawn in' John Day Reservoir, June to October 1982. Sample sizes are in parentheses.

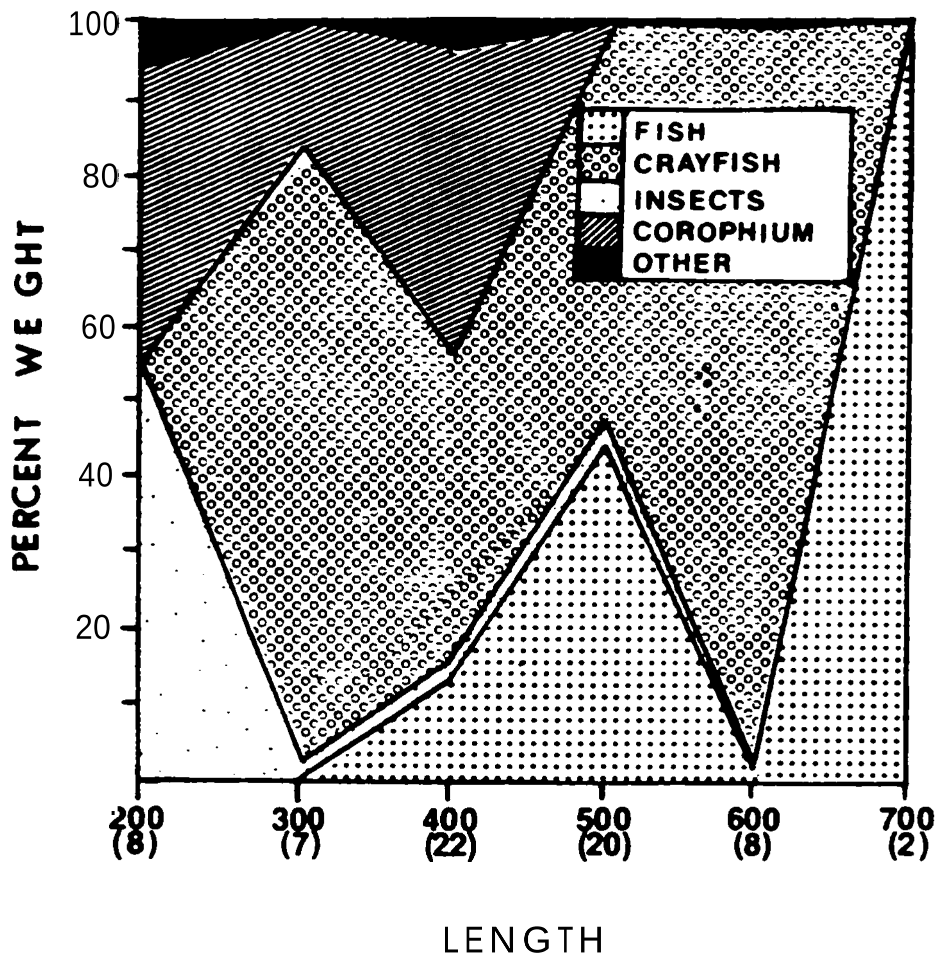

Figure 16. Percent weight of major food items and lengths of channel catfish collected in John Day Reservoir, June to October 1982. Lengths aie midpoints of 100 mm intervals. Sample sizes are in parentheses.

remained an important food item in channel catfish between 250-450 mm long while the percent by weight of insects declined and crayfish increased. Channel catfish over 450 mm long fed primarily on crayfish and fish.

Age Determination

Scales were collected from northern squawfish, walleye, and smallmouth bass, and pectorial spines from channel catfish during 1982. Interpretation of scale from walleye and smallmouth bass enabled us to construct age-length relationships for these species. Age-length relationships were based on scales collected from April through June 1982, immediately prior to, or during annulus formation. At present, bony structures of northern squawfish and channel catfish are undergoing preparation and analysis.

The age-length relation for walleye (Table 15) was fairly consistent among stations sampled. Mean total length for ages I - VI were 200 mm, 362 mm, 458 mm, 515 mm, 553 mm, and 600 mm, respectively.

The age-length relation for smallmouth bass (Table 16) differed among stations sampled. Average lengths of fish that were aged was consistently lower at John Day forebay than at other stations.

Table 15. Mean and range in length at various ages for walleye by station in John Day Reservoir and tailrace, April to June 1982. Sample sizes are in parentheses.

Station	Age 1	2	3	4	5	6	7	8
John Day tailrace								
Mean	194	346	436	532	546			749
Range	153-240	228-391	330-510	489-570	517-596			
	(25).	(36)	(42)	(7)	(3)			(1)
John Day forebay								
Mean	204	450	515			-	-	-
Range								
	(1)	(1)	(1)					
Irrigon								
Mean	-	427	483	511	511		-	-
Range		419-441	441-522	483-569				
		(3)	(12)	(4)	(1)			
McNary tailrace								
Mean	238	401	481	504			-	652
Range	205-302	351-455	403-530	461-567				
	(4)	(7)	(25)	(10)				(1)
Overall								
	200	362	458	515	553	600		701
Range	153-302	228-455	330-530	483-570	517-618	-		652-749
	(30)	(47)	(80)	(21)	(13)	(1)		(2)

Table 16. Mean and range in length at various ages for smallmouth bass by station in John Day Reservoir and tailrace, April to June 1982. Sample sizes are in parentheses.

Station	1	2	3	4	5	6	7	8	9	10	11	12
John Day tailrace												
Mean	98	153	259	335	356	-	409		-		-	-
Range		109-216	205-363		349-360		407-411					
	(1)	(13)	(8)	(1)	(3)		(2)					
John Day forebay												
Mean	81	137	205	250	310	343	-				501	-
Range	64-104	110-220	138-318	178-320	266-300	275-406						
	(11)	(31)	(146)	(32)	(19)	(5)					(1)	
Irrigon												
Mean	93	202	280	306	350	397	-	447	-		494	487
Range		148-242	231-341	240-372	277-402	370-415						
	(1)	(23)	(33)	(10)	(16)	(4)		(1)			(1)	(1)
McNary tailrace												
Mean		239	277	320	388	-	-					
Range		230-247	230-320	304-335	360-410							
		(2)	(22)	(2)	(4)							
All												
Mean	83	165	227	268	336	367	409	447	-		490	487
Range	64-104	109-247	138-363	178-372	266-410	275-415	407-411				494-501	-
	(13)	(69)	(209)	(45)	(42)	(9)	(2)	(1)			(2)	(1)

DISCUSSION

Juvenile salmonids were consumed by all four species of predators studied but the degree of predation varied as a function of spatial distribution, apparent abundance, size, and temporal feeding behavior. Northern squawfish were collected throughout John Day Reservoir and tailrace but apparent abundance was more than four times higher in summer and eight times higher in fall in restricted zones than at other areas. Mean number of salmonids consumed per northern squawfish was also higher in restricted zones at this time, with the exceptions of John Day forebay in summer and McNary tailrace in fall. The combination of high apparent abundance of northern squawfish and high mean number of juvenile salmonids per northern squawfish in restricted zones suggests that these may be sites of intense predation but they represent a small proportion of the reservoir habitat. Predation by northern squawfish was also observed at locations outside restricted zones, particularly at Irrigon and John Day forebay in spring, John Day forebay in summer, and McNary tailrace in fall. Assuming that calculated mean consumption estimates for these areas and times are representative, predation by even a relatively small population of northern squawfish would be substantial.

In contrast to northern squawfish, walleye were most often collected outside restricted zones in spring at John Day and McNary tailraces and Irrigon; few walleye were collected at John Day forebay in any season. In summer and fall apparent abundance of walleye decreased nearly to zero at all stations as near shore concentrations of walleye dispersed to deeper water.

@lean number of juvenile salmonids consumed by walleye in spring of 1982 was higher than for northern squawfish, smallmouth bass, or channel catfish at all stations except John Day forebay. Juvenile salmonids (primarily subyearling chinook) were the most important fish by weight in walleye collected at the John Day tailrace and Irrigon in the spring. However, it is unknown whether walleye are abundant enough to significantly affect juvenile salmonid survival.

Smallmouth bass were found throughout John Day Reservoir and tailrace but apparent abundance was highest outside the John Day forebay restricted zone and Irrigon. Smallmouth bass were also more commonly collected then northern squawfish or walleye on a reservoir wide basis. Wean consumption of juvenile salmonids by smallmouth bass in spring was lower at all stations than for northern squawfish or walleye but generally higher than channel catfish. Pew salmonids were observed in smallmouth bass stomachs in summer and fall. These data indicate that smallmouth bass are generally less predacious on juvenile salmonids then either northern squawfish or walleye. Predation by smallmouth bass on juvenile salmonids may still be substantial, however, because of their high abundance.

Channel catfish were low in abundance and consumed few juvenile salmonids at all stations in 1382. However, sampling was insufficient in tailrace habitats, an area where channel catfish are known to prey on juvenile salmonids in the Snake River (Bennett et al. 1983).

Several factors may have biased estimates of mean consumption of juvenile salmonids per predator. Over 4 million salmonids were released in the Umatilla River (river km 4661 just prior to sampling in spring. This may have inflated our spring consumption estimates. In addition, sample sizes ware not always adequate, particularly for northern squawfish in restricted zones in spring and walleye at all stations in summer and fall. Smolt condition should also be considered when estimating mean consumption in tailrace areas. It is likely that some juvenile salmonids consumed in tailrace areas were moribund or dead as a result of passage through the dam.

Several sampling modifications planned for 1983 will reduce biases observed in 1982. Restricted zones will be sampled during the spring smolt migration. Negotiations are currently underway with the Bonneville Power Administration and U. S. Army Corps of Engineers to schedule no-spill periods for this activity. An effort will also be made to collect more predators over a shorter time interval. This will be accomplished by more intensive sampling with gill nets at each station in spring and summer. To evaluate prey abundance during the period when predators are collected, prey size fish will oe collected with a boat electroshocker, gill nets, beach seine, and minnow traps.

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APPENDIX

Appendix 1 - Continued

Order: Decapoda

Family: Astacidae

Pacifastacus leniusculus

Class: Arachnida

Order: Acarina

Suborder: Trombidiformes

Order: Araneae

Class: Insecta

Order: Ephemeroptera

Family: Ephemeridae

Hexagenia limbata

Family: Ephemerellidae

Ephemerella Spp.

Order: Odonata

Suborder: Anisoptera

Order: Orthoptera

Order: Dermaptera

Family: Forficulidae

Order: Thysanoptera

Family: Thripidae

Order: Hemiptera

Family: Corixidae

Family: Lygaeidae

Appendix 1 - Continued

Family: Miridae

Family: Nabidae

Order: Homoptera

Family: Aphididae

Family: Cicadellidae

Family: Psyllidae

Order: Coleoptera

Family: Coccinellidae

Family: Helodidae

Family: Hydrophi lidae

Family: Psephenidae

Family: Scolytidae

Family: Staphylinidae

Order: Trichoptera

Family: Hydropsychidae

Order: Diptera

Family: Chironomidae

Family: Tipulidae

Order: Hymenoptera

Family: Apidae

Order: Lepidoptera

Phylum: Chordata

Appendix 1 - Continued

Class: Osteichthyes

Order: Clupeiformes

Family: Clupeidae

Alosa sapidissima

Order: Salmoniformes

Family: Salmonidae

Oncorhynchus tshawytscha

Prosopium williamsoni

Salmo gairdneri

Order: Cypriniformes

Family: Cyprinidae

Acrocheilus alutaceus

Mylocheilus caurinus

Ptychocheilus oregonensis

Family: Catostomidae

Catostomus columbianus

Catostomus macrocheilus

Order: Siluriformes

Family: Ictaluridae

Ictalurus spp.

Order: Percopsiformes

Family: Percopsidae

Appendix 1 - Continued

<u>Percopsis transmontana</u>

Order: Perciformes

Family: Centrarchidae

<u>Micropterus dolomieui</u>

Order: Scorpaeniformes

Family: Cottidae

<u>Cottus asper</u>

Appendix 2

List of taxonomic groups found in stomachs of walleye collected in John Day Reservoir and tailrace, April to December 1982.

Phylum: Arthropoda

Class: Crustacea

Order: Cladocera

Pamily: Bosminidae

Family: Daphnidae

Daphnia spp.

Order: Eucopepoda

Order: Mysidacea

Neomysis mercedis

Order: Amphipoda

Family: Gammaridae

Anisogammarus spp.

Family: Corophiidae

Corophium spp.

Order: DeCapoda

Family: Astacidae

Pacifastacus leniusculus

Class: Arachnida

Order: Acarina

Suborder: Trombidiformes

Appendix 2 - Continued

Class: Insecta

Order: Ephemeroptera

Family: Ephemeridae

Hexagenia limbata

Order: Orthoptera

Order: Hemiptera

Order: Homoptera

Family: Psyllidae

Order: Diptera

Family: Chironomidae .

Order: Hymenoptera

Phylum: Chordata

Class: Osteichthyes

Order: Salmoniformes

Family: Salmonidae

Oncorhynchus tshawytscha

Order: Cypriniformes

Family: Cyprinidae

Acrocheilus alutaceus

Mylocheilus caurinus

Ptychocheilus oregonensis

Richardsonius balteatus

Appendix 2 - Continued

Family: Catostomidae

Catostomus columbianus

Catostomus aacrocheilus

Order: Percopsiformes

Family: Percopsidae

Percopsis transmontana

Order: Scorpaeniformes

Family: Cottidae

Cottus asper

Appendix 3

List of taxonomic groups found in stomachs of smallmouth bass collected in John Day Reservoir and tailrace, April to December 1982.

Phylum: **Mollusca**

Class: Pelecypoda

Order: Heterodonta

Family: Corbiculidae

<u>Corbicula manilensis</u>

Phylum: Arthropoda

Class: Crustacea

Order: Cladocera

Family: Bosminidae

Family: Daphnidae

<u>Daphnia</u> spp.

Family: Leptodoridae

<u>Leptodora kindti</u>

Order: Eucopepoda

Order: Mysidacea

<u>Neomysis mercedis</u>

Order: Isopoda

Family: Asellidae

<u>Asellus</u> spp.

Order: Amphipoda

Family: Gammaridae

Appendix 3 - Continued

<u>Anisogammarus</u> spp.

Family: Corophiidae

<u>Corophium</u> spp.

Order: Decapoda

Family: Astacidae

<u>Pacifastacus leniusculus</u>

Class: Arachnida

Order: Araneae

Class: Insecta

Order: Ephemeroptera

Family: Ephemeridae

<u>Ephemerella</u> spp.

Family: Caenidae

order: Odonata

suborder: Anisoptera

Order: Orthoptera

Order: Thysanoptera

Order: Hemiptera

Family: Corixidae

Family: Rhopalidae

Order: Homoptera

Family: Aphididae

Appendix 3 - Continued

Order: Coleoptera

Order: Trichoptera

Family: Leptoceridae

Order: Diptera

Family: Chironomidae

Order: Hymenoptera

Family: Formicidae

Phylum:: Chordata

Class: Osteichthyes

Order: Clupeiformes

Family: Clupeidae

Alosa sapidissima

Order: Salmoniformes

Family: Salmonidae

Oncorhynchus tshawytscha

Order: Cypriniformes

Family: Cyprinidae

Acrocheilus alutaceus

nylocheilus caurinus

Ptychocheilus oregonensis

Family: Catostomidae

Catostomus columbianus

Appendix 3 - Continued

Catostomus macrocheilus

Order: Siluriformes

Family: Ictaluridae

***Ictalurus* spp.**

Order: Perciformes

Family: Centrarchidae

Order: Scorpaeniformes

Family: Cottidae

Cottus asper

Appendix 4

List of taxonomic groups found in stomachs of channel catfish collected in the John Day Reservoir, June to October 1982.

Phylum: Mollusca

Class: Pelecypoda

Order: Iieterodonta

Family: Corbiculidae

Corbicula manilensis

Phylum: Arthropoda

Class: Crustacea

Order: Amphipoda

Family: Gammaridae

Anisogammarus spp.

Family: Corophiidae

Corophium spp.

Order: Decapoda

Family: Astacidae

Pacifastacus leniusculus

Class: Arachnida

Order: Araneae

Class: Insecta

Order: Ephemeroptera

Family: Ephemeridae

Appendix 4 - Continued

Order: Odonata

Family: Libellolidae

Order: Coleoptera

Order: Trichoptera

Order: Diptera

Family: Chironomidae

Order: Hymenoptera

Phylum: Chordata

Class: Osteichthyes

Order: Salmoniformes

Family: Salnonidae

Oncorhynchus tshawytscha

Order: Cypriniformes

Family: Cyprinidae

Acrocheilus alutaceus

Cyprinus carpio

Family: Catostomidae

Catostomus columbianus

Catostomus macrocheilus

Order: Perciformes

Family: Centrarchidae

Order: Scorpaeniformes

Family: Cottidae

Cottus asper